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Rio Blanco Oil Shale Project

REVISED DETAILED DEVELOPMENT PLAN TRACT C-a

VOLUME 1

INTRODUCTION and EXECUTIVE SUMMARY

Gulf Oil Corporation – Standard Oil Company (Indiana)

May, 1977

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RIO BLANCO OIL SHALE PROJECT

REVISED
DETAILED DEVELOPMENT PLAN
TRACT C-a

VOLUME 1

SECTION 1 INTRODUCTION & EXECUTIVE SUMMARY

Submitted To Area Oil Shale Supervisor,
Geological Survey, U.S. Department of the Interior,
Pursuant To Lease No. C-20046

Gulf Oil Corporation – Standard Oil Company (Indiana)

May, 1977

REVISED DDP ABSTRACT

In 1969, the U. S. Department of the Interior initiated planning for a prototype oil shale leasing program that eventually resulted in Gulf Oil Corporation and Standard Oil Company (Indiana) acquiring an oil shale lease for Tract C-a in the Piceance Creek basin of northwest Colorado. Gulf and Standard submitted the high bonus bid for Tract C-a ($210,305,600) at a lease sale in Denver on January 8, 1974. Rio Blanco Oil Shale Project (RBOSP), an organization directed and staffed by representatives of Gulf and Standard, was formed later that year for the purpose of developing the tract.

RBOSP has conducted extensive geotechnical and environmental data collection programs to establish baseline conditions on and around Tract C-a and to provide input for the selection of mining and processing plans. This revised Detailed Development Plan (DDP) describes RBOSP's proposed development and operation of a commercial-scale oil shale complex and support facilities on and around Tract C-a. The development plan, environmental protection plans and environmental monitoring programs are based on the best technology presently available. Specific details of the engineering and environmental projections will change because of continually improving technology in these areas. RBOSP will be flexible and responsive to changes in information and technology and will incorporate new information into the project plans wherever warranted.

Before RBOSP can proceed with development of Tract C-a, several approvals and permits must be obtained from County, State and Federal governments. Among these are approval of the DDP, and acquisition of necessary rights-of-way and all permits for construction and operations, which presupposes the emissions and effluents from the operation will be acceptable under State and Federal regulations.

PROJECT DESCRIPTION

This revised DDP presents a 40-year plan for developing the oil shale resource on Tract C-a. This includes a 10-year Modular Development

Phase and a 30-year Commercial Phase. At the end of that time, approximately one-half of the tract will have been developed. RBOSP will develop the resources consistent with environmental, technical and economic constraints which prevail now or may exist in the future.

Development will consist of Modified In Situ (MIS) recovery of shale oil, on-tract surface retorting of the material brought to the surface, on-tract disposal of processed shale and waste materials and on-tract support facilities. The MIS method to be used by the Rio Blanco Oil Shale Project employs well known sublevel caving mining methods in combination with technology similar to in situ recovery of heavy oil from sand reservoirs in conventional oil fields. Mining involves the sinking of vertical shafts followed by development of rubblized zones which become underground retorts. The deposit is divided into cells of rubblized oil shale separated by pillars of undisturbed oil shale. Because most retorting occurs underground, the need for large off-tract processing and disposal areas is eliminated. The MIS method is considered by RBOSP as the best technique for achieving a combination of good resource recovery, minimum environmental impact and economic acceptability.

The two phases of the MIS operations include a Modular Development Phase and a Commercial Phase. The Modular Development Phase will consist of underground retorting only and will be conducted near the center of the commercial mine area during the first 10 years of operation (1977-86, including construction). During this time period, a number of retorts will be built and burned in sequence to gain operating experience, improve process efficiency, and confirm capital and operating costs for a commercial operation. The beginning of construction for the Modular Development Phase and all subsequent dates is keyed to timely approval of the DDP and the end of the suspension of operations granted by the Department of the Interior in 1976.

Engineering and construction for the Commercial Phase will begin in 1982 after results of the first prototype commercial-size retort, to be built

in 1981, have been analyzed. Completion of commercial-size retorts and support facilities is anticipated to take up to five years. During this period, single commercial-size prototype retorts will continue to be burned as part of the Modular Development Phase. Table 1 is a summary of information pertinent to RBOSP's proposed development of Tract C-a. Figure 1 depicts the location of proposed facilities.

The Modular Development Phase consists of developing several retorts off the same shaft. Retorts 1 and 2, starting in 1979, will allow evaluation of the retorting model prediction, provide practical field operating experience and supply samples for laboratory and field experiments. Retorts 3 and 4 will test mining concepts and the scaling-up of the size of the retorts. These two retorts will be developed and burned in 1980 and 1981.

Commercial scale operating conditions will be demonstrated in Retort 5 and beyond, with operations beginning in 1981. These retorts are large enough to be developed by the sublevel caving method. Objectives for the remaining prototype commercial retorts are to evaluate commercial-size retorts and continue to optimize both mining and retorting operations while the commercial facilities are under construction.

The shale oil produced in all Modular Development Phase retorts will be pumped to the surface and trucked to a market point. During this phase, a permit will be obtained from the Colorado Department of Health to thermally oxidize the gases before they are vented to the atmosphere. Mined material in the Modular Development Phase will be trucked from the mine and used for fill as required; the balance will be piled and re-vegetated.

Engineering and conceptual design work on the proposed facilities is based on producing 76,000 barrels per stream day (BPSD). This higher production rate resulted from conservative original estimates of component capacity. However, RBOSP intends to demonstrate commercial feasibility and other objectives of the prototype oil shale program at

an initial rate of about 50,000 BPSD. Should future conditions warrant, production could be expanded to 76,000 BPSD.

All environmental assessment was based on 76,000 BPSD production rate. The assessments and models show that RBOSP can satisfy environmental stipulations and regulations at this higher production rate. They can easily be met at the rate of 50,000 BPSD since environmental effects will be reduced in proportion to plant capacity.

Table 1

RIO BLANCO PROJECT SUMMARY

	MODULAR DEVELOPMENT PHASE	COMMERCIAL PHASE
Timing		
Construction	Sept. 1977-Oct. 1979	June 1982-Jan. 1987
Operation	Begin Oct. 1979	Begin Feb. 1987
Mine Development		
Ore Production (Average Brought to Surface)	Retorts 1-5, 500 TPSD Retorts 6 & up, 3000 TPSD	40,000 TPSD
Ore Rubblized (In Situ)	Up to 12,000 TPSD	134,000 TPSD
Ore Haulage (Surface)	Truck	Belt Conveyors
Processing		
Retorting-Surface	-	TOSCO II
Retorting-Underground	Modified In Situ	Modified In Situ
Processed Shale Haulage	-	Belt Conveyors
Products		
Shale Oil	Up to 4000 BPSD	76,000 BPSD
Sulfur	-	265 LTPSD
Product Movement	Truck (Shale Oil)	Pipeline (Shale Oil) Truck (Sulfur)
Net Groundwater Used	Up to 1000 AFY	2200 AFY
Power (Purchased)	Up to 40 MW	100 MW
Peak Employment	2500 for 76,000 BPSD 1900 for 50,000 BPSD	2075 for 76,000 BPSD 1550 for 50,000 BPSD

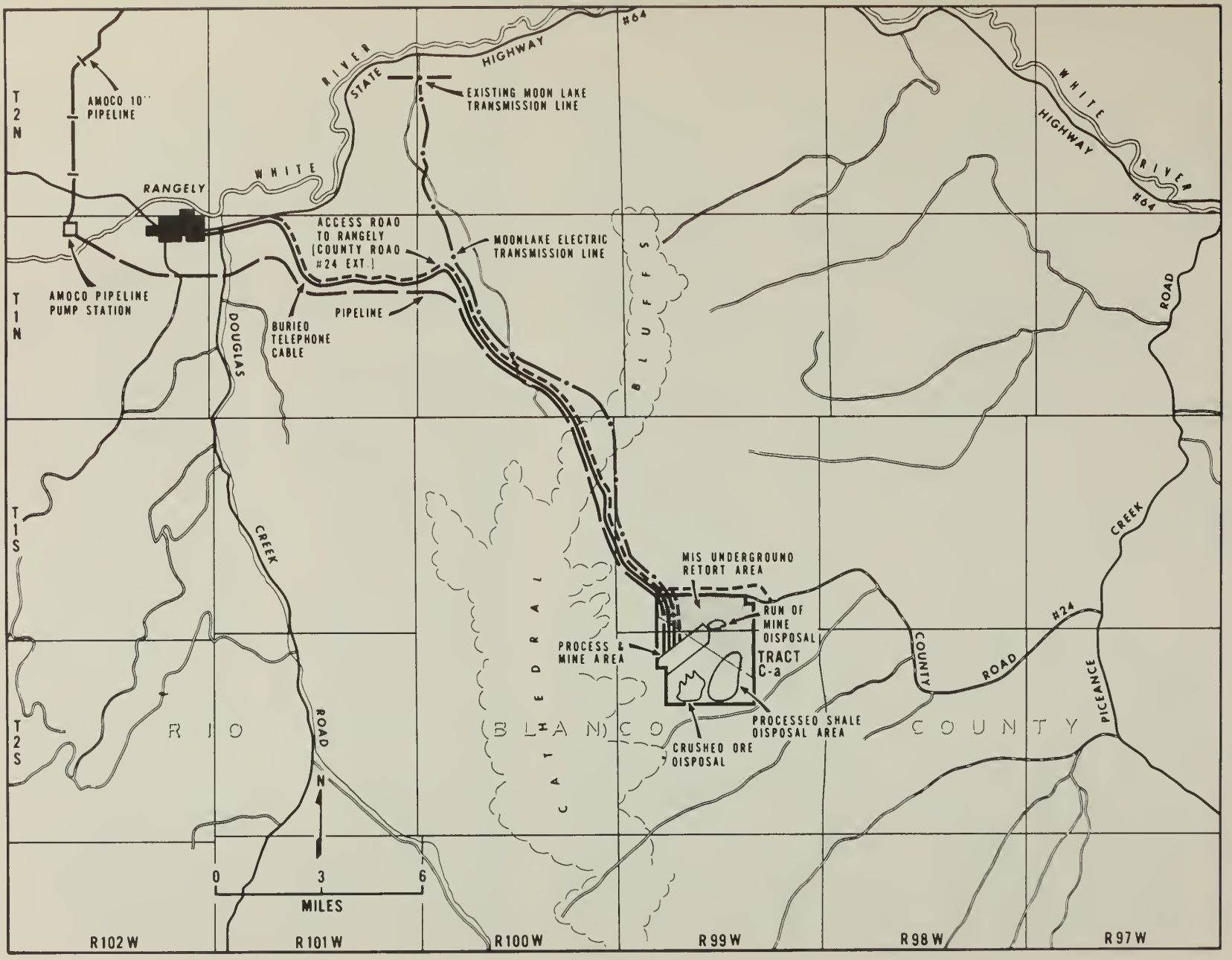

Figure 1

LOCATION OF RBOSP FACILITIES

Information learned from early commercial-size retorts will be used for engineering and construction of commercial production and service shafts, surface retorts, and support facilities beginning in 1982. The rubblized retorts for the Commercial Phase are designed to have void ratios of approximately 20% produced by mining and rubblization. Underground retorting by the Modified In Situ method could produce up to 57,000 BPSD. The ore produced in developing the voids will be crushed underground and stockpiled on the surface. The material will then be surface retorted to produce up to an additional 19,000 BPSD, bringing the total shale oil production to 76,000 BPSD. Sulfur will be recovered during the commercial operation. The low BTU offgases produced in the Commercial Phase will be utilized for power generation to supply most of RBOSP's electrical requirements.

The MIS retorts for 30 years of commercial production includes the richest, thickest oil shale within Tract C-a which is located in the northeast quadrant. The area proposed for retorting represents 10 years of modular development plus 30 years of commercial production and consists of about one-half of the tract.

Location of the disposal site for processed shale and the plant site are both on Tract C-a. Rinky Dink Gulch was selected for processed shale disposal because it is on tract and in an area of minimum surface drainage. Operationally, it is sufficient in size to hold the waste products and is close to the processing operations. Investigations are underway to determine if part or all of the processed shale could be injected into the spent retorts by slurrying for (1) ground stabilization, (2) sealing the retorts against leaching by groundwater, and (3) disposal of the processed shale. Selection of the processing facility site was based on its close proximity to the mine and disposal area which will reduce acreage disturbance. Also, the elevated topography will enhance dispersion of stack emissions and the relatively level terrain will minimize disturbance.

During the Modular Development Phase, the ore removed to create the 20% underground void volume will be transported to the disposal area by truck. During the Commercial Phase, it will be transported from the MIS mine area to the processing facility by belt conveyor. After surface retorting, processed shale will be transported to the disposal area from the plant site by belt conveyor. As final slopes are established on the disposal pile, the processed shale will be covered by coarse, crushed materials and covered with soil from the disposal areas. The disposal pile will be contoured, revegetated and progressively reclaimed as operations proceed.

During the Modular Development Phase, shale oil will be trucked to an existing refinery or markets. In the Commercial Phase, shale oil will be transported by pipeline to Rangely, Colorado. It will then be pumped through an existing Amoco pipeline to other connecting carriers for ultimate delivery to refineries or markets in the West or Midwest. If necessary, flow improvers will be added to the raw shale oil to make it a pipelineable product. The by-product sulfur recovered from retorting will be trucked from Tract C-a to rail facilities near Rifle, Colorado.

Mine dewatering during the Modular Development and Commercial Phases will produce more water than is required for project needs This excess water will be reinjected off-tract into the basin's aquifers. Up to 1000 acre-feet/year (AFY) of groundwater will be used during the Modular Development Phase, obtained from mine seepage and/or the dewatering wells. During the Commercial Phase, approximately 2200 AFY of groundwater will be used.

RBOSP will require the purchase of up to 40 megawatts (MW) of electricity during the Modular Development Phase operations. The demand will increase to about 100 MW during the Commercial Phase. Moon Lake Electric Association will supply electricity to Tract C-a via a 138 KV transmission line from an existing line near the White River 20 miles north of the tract. RBOSP will utilize the low BTU gas produced from MIS retorting to produce most of its electric power needs during the Commercial Phase.

Mountain Bell Telephone Company will provide communications from Rangely for commercial construction and operations. Vehicular access to Tract C-a will be via Rio Blanco County Road 24 (Ryan Gulch Road) from the east and via an extension of this road from the tract to Rangely on the west. The power transmission line, shale oil pipeline, and access road will be located, wherever possible, in a common corridor between Rangely and Tract C-a in accordance with the present Bureau of Land Management corridor concepts.

BASELINE ENVIRONMENTAL AND GEOTECHNICAL CONDITIONS

Collection of baseline environmental data on and around Tract C-a began in October, 1974. Since individual tasks started at various times, two full years of collection in some categories were not completed until early February, 1977. The program was designed to gather extensive environmental data for the purposes of (1) complying with lease stipulations to describe baseline environmental conditions prior to development and, (2) developing a scientifically sound environmental data base to help in the design of an environmentally acceptable DDP. During planning and development of the baseline programs, environmental lease stipulations were subjected to critical review. Potential data gaps inherent in the stipulations were identified and suggestions for amendments to the lease were made.

After thorough evaluation and study, a final scope of work was submitted to and approved by the Area Oil Shale Supervisor (AOSS) following review and recommendation by the Oil Shale Environmental Advisory Panel.

Programs were developed to study several areas of environmental concern including meteorology and air quality, and terrestrial and aquatic ecology. The programs were also designed to describe interrelationships among components of the ecosystem and identify areas of cultural resources. The environmental baseline conditions and analyses upon which the DDP environmental information is based were submitted as a separate report to the AOSS in May, 1977 entitled "Final Environmental Baseline Report for Tract C-a and Vicinity."

Geotechnical data gathering, including geologic and hydrologic resource evaluation through core hole drilling and geophysical logging, began in July of 1974. The geologic program conducted by RBOSP provides detailed structural, stratigraphic and resource data.

The hydrologic program conducted by RBOSP provides the data for determining the hydrologic environmental baseline, aquifer characteristics, and quality and quantity of water expected to be produced from various mining plans.

ENVIRONMENTAL PROTECTION

RBOSP's plan is to construct and operate an environmentally acceptable oil shale operation. Specific environmental protection procedures have been developed to ensure compliance with lease provisions and with all applicable Federal, State and local environmental protection and pollution control regulations. The procedures and mitigation plans are designed specifically for RBOSP's intended development of Tract C-a and will be modified as necessary with changing conditions. The protection procedures described in the development plan cover the following topics:

- Health and Safety
- Air Quality Control
- Water Quality Control
- Solid Waste Control
- Noise Control
- Aesthetics
- Abandonment
- Fish and Wildlife Management
- Land Rehabilitation
- Oil and Hazardous Materials Control
- Fire Prevention and Control
- Protection of Objects of Historic and Scientific Interest
- Subsidence Control

RBOSP's assessment of potential environmental impacts which could result from Tract C-a activities include studies of air and water quality, terrestrial and aquatic biology, and cultural resources. Assessments were based on emissions, dispersion modeling and tracer studies, water flow modeling, and in-depth analyses of environmental baseline.

Environmental monitoring programs have been designed to provide data which will identify impacts to the environment resulting from development activities. Changes from conditions existing prior to development as established by the baseline data collection program will be recorded. These programs will allow evaluation of the success of the mitigation plans. Should the monitoring programs show that the control plans are not working as predicted, the control plans will be modified to enhance their effectiveness.

A monitoring program has been initiated since the baseline programs were completed on Tract C-a. Monitoring will continue, as the lease requires, until the Area Oil Shale Supervisor determines to his satisfaction that environmental conditions consistent with Federal and State statutes and regulations have been established.

SOCIAL AND ECONOMIC PLANNING

Gulf and Standard began working with the people of northwestern Colorado shortly after acquiring the Tract C-a lease in 1974. Recognizing the importance of dealing with the potential social and economic impacts of oil shale development, the companies participated in planning with local, County, State and Federal governmental agencies.

Although a social and economic impact statement was not required by the Tract C-a lease, RBOSP officials and the Area Oil Shale Supervisor felt such a plan was desirable. Therefore, the Social and Economic Impact Statement for Tract C-a was submitted as a separate document along with the Detailed Development Plan. An addendum which updates the statement was submitted with the revised DDP.

The overall objective of the plan is to reduce negative impacts which have occurred in other areas because of industrial activity. In addition to the Social and Economic Impact Statement, Gulf and Standard sponsored the preparation of a master plan for the town of Rangely, Colorado, which has been adopted by the community and has been certified by Rio Blanco County.

DDP ORGANIZATION AND USE

RBOSP's DDP consists of 8 sections comprising 3 volumes, as depicted in the chart on page 12. Volume 1 is the "Executive Summary". If one is interested in an overview of the development plan, Volume 1 is recommended.

Volume 2 describes engineering plans for developing Tract C-a and includes sections on mining, processing, processed shale disposal and support facilities. Volume 3 describes RBOSP's environmental protection plans and also includes sections concerning environmental assessment and monitoring. The Confidential Volume, which is not publicly available, contains proprietary information concerning oil shale properties, ore reserves and cost estimates.

Except for this DDP abstract, a 3-number page numbering system is used throughout the development plan. Any given page number is unique in that it is not repeated elsewhere in the DDP. Page numbers are keyed to chapters within sections; page 2-6-15, for example, refers to Section 2, Chapter 6, page 15.

RIO BLANCO OIL SHALE PROJECT
MIS-DETAILED DEVELOPMENT PLAN ORGANIZATION

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SECTION 1
INTRODUCTION & EXECUTIVE SUMMARY

CHAPTER 1
PROJECT BACKGROUND AND OVERVIEW

1.1 PROJECT BACKGROUND

A. Introduction - The Green River Formation oil shales occurring beneath a 25,000-square mile area in northwestern Colorado, northeastern Utah and southwestern Wyoming represent the world's largest known concentration of hydrocarbon resources. The amount of oil ultimately recovered from this vast storehouse of energy will depend on technical, economic and environmental constraints, but could vary from 80 billion to more than one trillion barrels.

Attempts to produce shale oil on a commercial basis in the United States date back to the 19th century, but economics and technology always became the deciding factor in preventing development. With dwindling world reserves of conventional sources of petroleum and attendant higher prices, oil shale development now appears to be required as a means of supplementing the world energy needs.

This Detailed Development Plan (DDP) describes a program by which Gulf Oil Corporation and Standard Oil Company (Indiana) intend to engage in commercial production of shale oil from Federal Tract C-a in the Piceance Creek basin of northwest Colorado. It is submitted in accordance with provisions of an oil shale lease (Serial No. C-20046) issued to Gulf and Standard in February 1974 by the Bureau of Land Management, U. S. Department of the Interior (DOI).

B. Prototype Oil Shale Leasing Program

1. Historical - The Department of the Interior's Prototype Oil Shale Leasing Program dates back to planning activities initiated in October 1969 after a previous leasing attempt was unsuccessful in December 1968.

An interagency oil shale task force was formally established in December 1969 and its work was seemingly culminated in May 1970 with submission of a proposed program to then Interior Secretary Walter J. Hickel. But Secretary Hickel rejected the proposal and directed the task force to further evaluate the environmental effects of the program before it was implemented.

This led to the creation of joint State-Federal-industry committees (appointed by the Governors of Colorado, Utah and Wyoming) to study the environmental aspects of oil shale development in each of the three states. Their studies were completed and reports submitted to the Interior Secretary in February 1971. The information in these reports was used to prepare a draft environmental impact statement and it, together with a program statement on the proposed prototype program, was released to the public on June 29, 1971.

Release of these documents, which set in motion the events that led to the 1974 oil shale lease sales, was preceded by President Nixon's "Clean Energy" message to Congress on June 4, 1971, wherein he said,

> "I believe the time has come to begin the orderly formulation of a shale oil policy -- not by any head-long rush toward development but rather by a well-considered program in which both environmental protection and the recovery of a fair return to the Government are cardinal principles under which any leasing takes place."

The first step in the leasing program announced on June 29, 1971, was informational core hole drilling by firms interested in acquiring an oil shale lease; industry responded by drilling 16 holes during the fall and and winter of 1971-72. At Interior's invitation, industry then nominated 20 tracts in Colorado, Utah and Wyoming as potential lease areas in January 1972. Interior selected six tracts, two in each state, as having the best potential for satisfying the goals and objectives of the

prototype program. Additional informational core hole drilling was conducted during 1972 and 1973.

A revised and greatly expanded draft EIS on the program was released in September 1972. A series of public hearings was held a month later in the states in which the selected lease tracts were located. This was followed by another 11 months of work by Interior's oil shale task force before the final environmental impact statement was released on August 30, 1973. Three months later (on November 28, 1973) Interior Secretary Rogers C. B. Morton announced his decision to proceed with the program and that the first lease sale (of Colorado Tract C-a) would be held in January 1974. Gulf and Standard submitted the high bonus bid for Tract C-a of $210,305,600.00 at the sale in Denver on January 8, 1974. The lease was formally signed by the Colorado State Director of the Bureau of Land Management on February 5 and became effective on March 1, 1974.

2. Objectives - The objectives of the Department of the Interior in its prototype leasing program, as set forth in the June 1971 program statement, are to:

- Provide a new source of energy to the Nation by stimulating development of commercial oil shale technology by private industry;
- Ensure the environmental integrity of the affected areas and at the same time to develop a full range of environmental safeguards and restoration techniques that will be incorporated into the planning of a mature oil shale industry, should one develop;
- Permit an equitable return to all parties in the development of this public resource; and
- Develop management expertise in the leasing and supervision of oil shale development in order to provide the basis for future administrative procedures.

Gulf and Standard concur with and support these objectives and, as oil shale lessees, have the following overall goal:

- To engage in commercial production of shale oil and associated products or by-products from Tract C-a at as high a production rate as is feasible, consistent with environmental, technical and economic constraints that now prevail or may exist in the future.

In accordance with rules established by the Department of the Interior, a preliminary plan for development of Tract C-a was submitted to DOI by Gulf and Standard in early February 1974, within 48 hours after being notified that they had been awarded the lease for Tract C-a. The preliminary development plan expressed, in more detail, the companies' planning objectives with respect to Tract C-a development:

- To comply with lease terms requiring submittal of data for review by appropriate government agencies and also to keep the public informed of plans and progress through a series of regular progress reports;
- To conceive, coordinate and execute engineering studies of mining and processing methods and equipment in a manner designed to enhance project economics and achieve the earliest feasible start-up date;
- To incorporate environmental considerations into project engineering studies and decisions throughout the life of the project;
- To submit for approval of the Area Oil Shale Supervisor, at the earliest possible date, an acceptable plan describing the exploratory work proposed to be undertaken on the tract;
- To see that the general requirements set forth in the lease's environmental stipulations are transformed into specific plans that will address all aspects of the lease;
- To conduct an integrated environmental baseline study of the total ecology of Tract C-a to provide an understanding of the

basic ecological interrelationships important for successful environmental protection and to allow identification of those ecological parameters that are important to be monitored as indicators of environmental quality;

- To gather socio-economic data directly related to project development as an aid to projections and assessments of probable impacts resulting from a prototype oil shale industry in the area and to estimate the number of construction and operating employees required; and
- To cooperate with, support and participate in regional planning by the communities affected and with local, County, State and Federal government agencies.

This Detailed Development Plan responds to the first six items listed above while RBOSP's "Social and Economic Impact Statement for Tract C-a," and the Rangely Master Plan, a study funded by the Rio Blanco Oil Shale Project for the town of Rangely, Colorado, respond to the last two items.

C. Lease Provisions

1. Tract C-a Location - Tract C-a comprises about 5,100 acres in Rio Blanco County, Colorado, about 20 miles southeast of Rangely. The specific lands covered by the Tract C-a lease are legally described as follows:

T1S, R99W, 6th P.M.
Sec. 32: E1/2, E1/2W1/2
Sec. 33: All
Sec. 34: W1/2, SE1/4, W1/2NE1/4, SE1/4NE1/4

T2S, R99W, 6th P. M.
Sec. 3: All
Sec. 4: All
Sec. 5: E1/2, E1/2W1/2 (incl. Lots 1, 2, and 3)
Sec. 8: E1/2

Sec. 9: All
Sec. 10: All

Figure 1-1-1 depicts surface ownership of Tract C-a and vicinity.

2. Term - The oil shale lease issued to Gulf and Standard on February 5, 1974, is for a period of 20 lease years from the effective date (March 1, 1974) and so long thereafter as there is production from the leased deposits in commercial quantities, subject to readjustment of terms and conditions at 20-year intervals following the effective date.

3. Bonus Payments - Pursuant to procedures established by the Department of the Interior for the Prototype Leasing Program, Gulf and Standard submitted a check for $42,061,120.00 on the day of the Tract C-a bid opening to cover one-fifth of the bonus amount bid. Subsequent bonus installments in like amounts were submitted to the Bureau of Land Management on the first anniversary date March 1, 1975, and the second anniversary date, March 1, 1976. Section 5 of the Tract C-a oil shale lease provides that Gulf and Standard can credit development expenditures made prior to the third lease anniversary date against the fourth bonus installment due on the third anniversary date. Similarly, development expenditures made before the fourth anniversary date can be credited against the fifth bonus installment due on the fourth anniversary date; also creditable to the fifth bonus payment are any expenditures made before but not credited against the fourth bonus payment. Any suspension of the lease delays the anniversary dates for a time equal to the period of suspension. To qualify as credits, expenditures must, according to the lease, be directly attributable to operations on the leased lands for development of the leased deposits; expenditures made for preparation of the Detailed Development Plan do not qualify. In June 1975, the Department of the Interior published guidelines which further clarify the types of expenditures that may be credited against bonus payments.

Section 5 also provides that Gulf and Standard may relinquish the lease at any time prior to the third anniversary date and be relieved of any

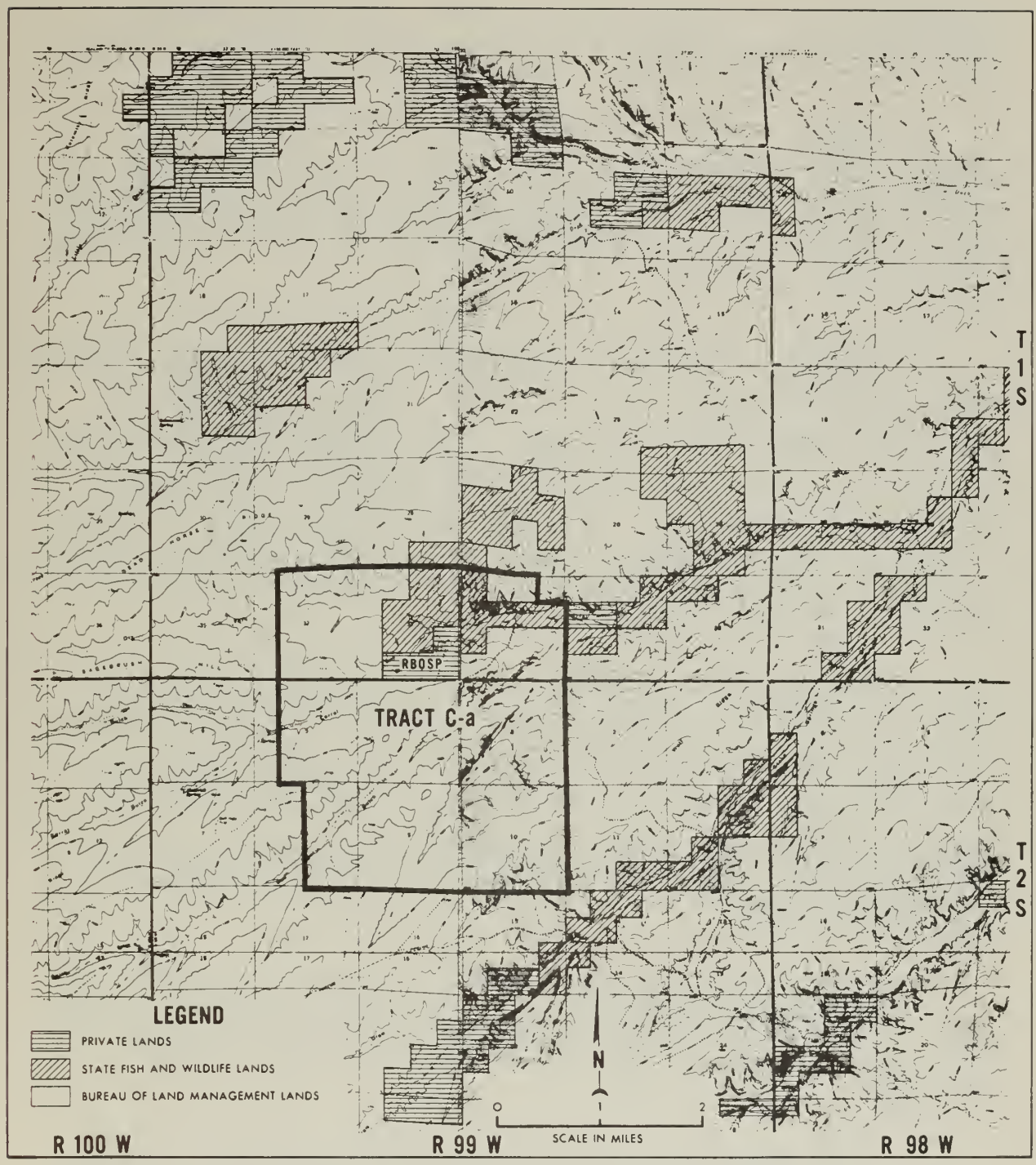


Figure 1-1-1
SURFACE OWNERSHIP

obligation to pay the fourth and fifth bonus installments mentioned above. The total bonus payment, in that event, would be $126,183,360.00.

4. Rentals - Annual rental for Tract C-a land is 50 cents per acre, or fraction thereof, except that rental for any lease year can be credited against any royalty payments due and payable in that lease year; in those years when no royalties are due, the rental for the tract is $2,545.00.

5. Royalties - The lease contains provisions for computing royalties due on production from Tract C-a. The royalty rate is adjusted each year by the change (either up or down) in the combined average value per barrel of all crude oil and crude shale oil produced in the states of Colorado, Wyoming and Utah. The payment of a minimum royalty is required in the sixth and each succeeding lease year even if no actual production has been achieved by that time.

Certain lease provisions allow for reducing royalties due on actual production during lease years 6 to 10. In addition, the lease provides that annual rentals may be credited against royalty due in any lease year and that the Interior Secretary may excuse Gulf and Standard from compliance with minimum royalty requirements during any year in which the lessees are prevented from implementing the DDP by circumstances beyond their control.

6. Environmental Protection - The lease contains specific requirements for environmental protection and for developing environmental information. Section 11 reads:

> "The lessee shall conduct all operations under this lease in compliance with all applicable Federal, State and local water pollution control, water quality, air pollution control, air quality, noise control, and land reclamation statutes, regulations, and standards."

"The lessee shall avoid, or, where avoidance is impracticable, minimize and, where practicable, repair damage to the environment, including the land, the water and air."

Also incorporated in the lease is a lengthy list of environmental stipulations dealing with the following topics:

- Access and service plans
- Fire prevention and control
- Fish and wildlife
- Health and safety
- Historic and scientific values
- Oil and hazardous materials
- Air pollution
- Water pollution
- Noise control
- Rehabilitation
- Scenic values
- Vegetation
- Waste disposal

The environmental stipulations require the collection of baseline environmental data for two consecutive full years, one full year of which was required before submission of the Detailed Development Plan. The lease further requires that, after collecting baseline data for two years, Gulf and Standard must conduct an environmental monitoring program beginning six months prior to commencement of development operations; the monitoring program must continue until the Area Oil Shale Supervisor is satisfied that environmental conditions consistent with applicable Federal and State statutes and regulations are established.

7. Suspension - Suspension of operations was granted to the Gulf Oil Corporation and Standard Oil Company (Indiana) beginning on September 1, 1976 and scheduled to terminate on September 1, 1977, unless extended by the Mining Supervisor. Section 39 of the Mineral Leasing Act (30 USC

209) and Sections 1(d) and 22 of the Oil Shale Lease establish the authority and define the procedure for the Department of the Interior to grant suspensions of operations for oil shale leases in the interest of conservation of the resource. Conservation of the resource has been defined broadly by the Department and the courts to include conservation of environmental resources, as well as mineral resources. The Secretary's authority to grant suspensions has been delegated to mining supervisors of the U. S. Geological Survey by Departmental Order 2699 and Geological Survey Order 218. (43 CFR 3103.38).

The suspension of operations was subjected to a list of conditions including:

- Completion of the two-year Baseline Data Collection Program pursuant to the existing approved program.
- Submission of a final report on the two-year baseline program analyzing the data collected.
- Implementation of an interim environmental monitoring program beginning immediately upon completion of the two-year baseline data program and based on continuing analysis of the data from the baseline program. The purpose of the program was: to maintain continuity of data gathering on critical parameters of the environmental baseline program; to further explore identified problem areas; to provide the Government and the Lessee with further knowledge of environmental conditions on the lease tract, and to permit rapid commencement of operation at the end of the suspension period.
- Continuation of revegetation experimental programs.

D. Detailed Development Plan

1. Requirement for Detailed Development Plan - The requirement for filing a detailed development plant (DDP) with the Area Oil Shale Supervisor (AOSS) on or before the third anniversary date of the lease may be found in Section 10 of the oil shale lease. The DDP, according to the

lease, is to include the following:

- A schedule of the planning, exploratory, development, production, processing and reclamation operations and all other activities to be conducted under the lease; and
- A detailed description pursurant to 30 CFR Part 231 and 43 CFR Part 23 of the procedures to be followed to assure that the DDP and all operations thereunder will meet and conform to the environmental criteria and controls incorporated in the lease.

Furthermore, the DDP is to reflect a program ensuring due diligence for the orderly development of the leased deposits.

Section 1c of the environmental stipulations incorporated in the lease indicates that an environmental monitoring program is to be an integral part of the DDP. Also, at the time the DDP is submitted, Gulf and Standard are to provide to the Area Oil Shale Supervisor a complete compilation of the baseline environmental data collected to date pursuant to the lease. In addition, development of a Fish and Wildlife Management Plan for the tract is required in the environmental stipulation of the lease.

The Environmental baseline conditions and analyses upon which the DDP environmental information is based have been submitted as a separate report to the AOSS in May, 1977, entitled "Final Environmental Baseline Report for Tract C-a and Vicinity."

2. History of the DDP - In March 1976, the Rio Blanco Oil Shale Project (RBOSP), sponsored by Gulf and Standard, submitted a Detailed Development Plan to the Area Oil Shale Supervisor. This DDP called for open pit mining, surface retorting, and off-tract locations for processing facilities, overburden and processed shale. This plan projected a modular approach for development of the tract.

As RBOSP prepared the DDP and identified various requirements to meet its objectives, a number of serious deterrents became apparent. As soon as the problems surfaced, RBOSP attempted to solve them. However, some problems remained unresolved and caused RBOSP to request a suspension which was granted for one year effective September 1, 1976. During the suspension period, RBOSP prepared a revised DDP calling for Modified In Situ development combined with surface retorting of the oil shale mined from the Modified In Situ retorts.

3. Availability and Public Review - This revised DDP, May 1977, is available for review by all interested Federal, State, County and local government agencies and the general public. Copies may be inspected at the Area Oil Shale Supervisor's Office in Grand Junction, Colorado. As required by the lease, the review process will include public hearings on the environmental aspects of the DDP. The Oil Shale Environmental Advisory Panel will review and make recommendations concerning the DDP to the AOSS. The only portion of the DDP not available for public review is a Confidential Volume containing proprietary technical information, ore reserves and financial data.

4. Approval - Development operations on Tract C-a cannot begin until the AOSS has approved the DDP.

E. Lease History

1. Creation of Rio Blanco Oil Shale Project - The first several months after award of the lease were devoted to various organizational tasks that culminated on July 10, 1974 when Gulf and Standard announced creation of the Rio Blanco Oil Shale Project, directed and staffed by employees, composed of representatives from each parent company. RBOSP's sole purpose is the development of Tract C-a.

2. Exploratory Plan - In May 1974, an exploratory plan as required by Section 10d of the lease was submitted to and approved by the Area Oil Shale Supervisor of the U. S. Geological Survey. The document

detailed plans by Gulf and Standard for obtaining environmental baseline data, establishing monitoring programs and acquiring resource data needed for studies leading to the selection of the mining, processing, and environmental protection systems and procedures that are the subject of this Detailed Development Plan.

3. Geotechnical Data Collection - Geotechnical data gathering, including geologic and hydrologic resource evaluation through core hole drilling and geophysical logging began in July 1974. The geologic program conducted by RBOSP was designed to provide detailed structural, stratigraphic and resource data.

The hydrology program was conducted by RBOSP to provide the data for determining the following: (1) hydrologic environmental baseline, (2) aquifer characteristics and quality, and (3) quantity of water expected to be produced from various mining plans.

4. Baseline Environmental Data Collection - Baseline data collection efforts were initiated in October 1974. This program was designed to gather extensive environmental data for the purposes of (1) complying with lease stipulations to describe baseline conditions prior to development and (2) developing a scientifically sound data base from which RBOSP could draw information for the design of an environmentally acceptable DDP. During planning and development of the baseline programs, environmental lease stipulations were subjected to critical review. Potential data gaps inherent in the stipulations were identified and suggestions for amendments to the lease were made.

After thorough evaluation and study, a final scope of work was submitted to and approved by the Area Oil Shale Supervisor following review and recommendation by the Oil Shale Environmental Advisory Panel. Programs were designated to determine meteorology and air quality, to study terrestrial and aquatic ecology, to describe interrelationships among components of the ecosystem, and to identify areas of cultural resources.

Since individual tasks started at various times, two full years of collection in some categories were not completed until early February 1977. RBOSP retained the NUS Corporation to compile the baseline information into a final environmental baseline report in accordance with lease stipulations. This was submitted to the AOSS in May 1977.

5. Quarterly Progress Reports - Baseline geotechnical and environmental data have been regularly described in quarterly progress reports prepared by Rio Blanco Oil Shale Project. The first such report was submitted to the Area Oil Shale Supervisor in October 1974; it covered the period from lease issuance through September 30, 1974. Nine subsequent quarterly progress reports were submitted to the AOSS, the last being in May 1977. Additional information will continue to be submitted to the AOSS. These quarterly reports and the accompanying field data are on file in the Area Oil Shale Office in Grand Junction, Colorado.

6. Mining and Processing Studies - RBOSP used information provided by the Lawrence Livermore Laboratory of the University of California and data from the Laramie Energy Research Center for studying a Modified In Situ (in place) shale oil recovery plan. Information was also obtained from other ERDA affiliated laboratories for these in situ studies.

RBOSP retained Golder Associates (Mining studies), Foster Wheeler Energy Corporation (Processing studies), and Morrison Knudsen Company (Support Facilities and Operations studies) to perform engineering studies to encompass all phases of developing a major oil shale mine and processing plant plus the necessary support facilities for production of crude shale oil in commercial quantities. The primary objectives of the studies, completed in May 1977, were (1) to provide information for inclusion in the Detailed Development Plan and (2) to examine the technical and economic viability of the Tract C-a project.

7. Assessment Studies - Potential environmental impacts which could result from Tract C-a development activities were studied for air and water quality, terrestrial and aquatic biology and cultural resources.

Assessments were quantified to the greatest degree possible by use of a "cause-effect" matrix analyses in which potential impacts were ranked as to their severity. These results and analyses of the data taken during the two year baseline environmental program were used to develop an operational monitoring program. NUS Corporation and Wright Water Engineers were engaged to perform these assessments and NUS designed the monitoring program.

1.2 PROJECT OVERVIEW

RBOSP has looked at virtually every known mining and processing technique that could be used for oil shale development in order to examine all alternatives or potential modifications to the original DDP. As a result of this examination, RBOSP decided to develop a mining and retorting plan for Modified In Situ (MIS) recovery of oil from oil shale.

The Modified In Situ process requires that some of the shale be mined to prepare the remainder for in situ retorting. In this operation, about 20% of the in-place oil shale is removed to the surface to be retorted in surface equipment. A "pure" in situ process (leaving all the oil shale underground and requiring no underground mining) does not appear to be technically feasible at this time.

A. Development Objective - The ultimate goal of the Rio Blanco Oil Shale Project is to engage in commercial production of shale oil and associated by-products from Tract C-a at as high a production rate as is feasible, consistent with environmental, technical and economic constraints that now prevail or may exist in the future. RBOSP believes it is prudent to proceed initially on a small scale to prove technical, environmental and economic feasibility. A modular approach will therefore be employed, rather than immediately constructing a full-scale commercial complex.

Engineering and design work on the proposed facilities is based on producing 76,000 barrels per stream day (BPSD). This higher production rate resulted from conservative original estimates of component capacity. However, RBOSP intends to demonstrate commercial feasibility and other objectives of the Federal prototype oil shale program at an initial rate of about 50,000 BPSD. Should future conditions warrant, production could be expanded to 76,000 BPSD. All environmental assessment was based on 76,000 BPSD production rate. The assessments and models show that RBOSP can satisfy environmental stipulations and regulations at this higher production rate. They can easily be met at the rate of 50,000 BPSD since environmental effects will be reduced in proportion to plant capacity.

The Modular Development Phase, beginning in 1977 is planned at an increasing scale in order to gain operating experience, improve process efficiency, confirm capital and operating cost estimates, and verify the environmental integrity of the mining and processing operations.

The Commercial Phase is the planned operation of a full-scale commercial complex beginning in 1987. Production could eventually be approximately 76,000 BPSD, with 57,000 BPSD being produced by Modified In Situ retorting and 19,000 BPSD from surface retorting. Since Tract C-a oil shale reserves are adequate to support a higher production rate, RBOSP will continually evaluate the project's success and may elect to increase production above 76,000 BPSD at any time following the proof of commercial feasibility. In that event, RBOSP would file an amendment to this development plan with the Area Oil Shale Supervisor, as required by the lease.

This Detailed Development Plan describes the 10 years of the Modular Development Phase in detail. The Commercial Phase design and operation are conceptual in nature but still with enough specific information to permit a meaningful assessment of the environmental effects of operations at the Commercial Phase production level for 30 years.

The development plan, environmental protection plans and environmental monitoring programs described in this DDP are based on the best technology presently available. Specific details concerning engineering or environmental design of these plans and programs will change because technology in these areas is continually changing and improving. RBOSP will be flexible and responsive to changes in information and technology and will incorporate new information into the project plans where warranted. The monitoring programs are designed to provide data which will identify impacts to the environment which result from development activities. This will allow evaluation of the success of the mitigation plans. Should the monitoring program show that the control plans are not working as predicted, the control plans will be modified to enhance their effectiveness.

The monitoring programs described have been developed through analyses of data taken during the two-year baseline data gathering program, review of previously reported literature, and a sophisticated cause and effect matrix analysis. Additional data collected during the suspension monitoring or operational monitoring programs may reveal long-term trends not discernable with only two years baseline data. If so, the environmental monitoring programs will be altered in view of new information.

Thus, as a general principle, RBOSP anticipates modification of this program as necessary to include more efficient ways of developing oil shale with minimal environmental impact. RBOSP's plan is to construct and operate an environmentally-sound oil shale complex. Protection of the three principal components of the environment will be accomplished by RBOSP in the following manner:

- Water quality control will be achieved through the implementation of a zero surface discharge concept.
- Air quality control will be achieved by using equipment and facilities designed to minimize adverse pollutant emissions and by applying the best technology available to control any emissions that cannot otherwise be reduced by design changes.

- RBOSP's objective will be to avoid or minimize land distrubance wherever practicable. Rehabilitation of disturbed land will be undertaken through a program incorporating site preparation erosion control and revegetation.

B. Overall Project Description and Development Schedule - The proposed development plan presented in this document consists of a rubblized in situ extraction process for recovery of oil from oil shale, a modified sublevel caving method of mining, on-tract surface retorting, and on-tract disposal of processed shale. Tract C-a development will be undertaken in two operating phases. The Modular Development Phase consists of sequentially developing and operating a number of retorts in order to demonstrate commercial feasibility and to continue operations while the commercial retorts are being prepared. The Commercial Phase will consist of burning several retorts in situ while surface retorting part of the oil shale. Table 1-1-1 is a summary of information pertinent to RBOSP's proposed development of Tract C-a. Figure 1-1-2 shows RBOSP's proposed construction and operating schedule.

The Modular Development Phase plans consist of developing at least six retorts. Initially, two 30'x30'x140' (high) retorts are developed, rubblized and burned in a sequence where the first is burned before the second is developed. Planned access to the retorts is down vertical shafts to and through horizontal drifts to the retorts. This will serve all of the retorts in the Modular Development Phase. The objectives of this demonstration are to achieve operational success for a given set of conditions and to refine these operating conditions.

Next, two 50'x100'x140' (high) retorts are developed. Burning of retort number 3 will follow after completing the burn of the number 2 retort, and development, rubblizing and burning of the number 4 retort will follow after the burning of the third retort has been completed. The objectives of this demonstration are to continue to refine operating conditions, extrapolate permeability, and test mining methods.

Table 1-1-1

RIO BLANCO PROJECT SUMMARY

	MODULAR DEVELOPMENT PHASE	COMMERCIAL PHASE
Timing		
Construction	Sept. 1977-Oct. 1979	June 1982-Jan. 1987
Operation	Begin Oct. 1979	Begin Feb. 1987
Mine Development		
Ore Production (Average Brought to Surface)	Retorts 1-5, 500 TPSD Retorts 6 & up, 3000 TPSD	40,000 TPSD
Ore Rubblized (In Situ)	Up to 12,000 TPSD	134,000 TPSD
Ore Haulage (Surface)	Truck	Belt Conveyors
Processing		
Retorting-Surface	-	TOSCO II
Retorting-Underground	Modified In Situ	Modified In Situ
Processed Shale Haulage	-	Belt Conveyors
Products		
Shale Oil	Up to 4000 BPSD	76,000 BPSD
Sulfur	-	265 LTPSD
Product Movement	Truck (Shale Oil)	Pipeline (Shale Oil) Truck (Sulfur)
Net Groundwater Used	Up to 1000 AFY	2200 AFY
Power (Purchased)	Up to 40 MW	100 MW
Peak Employment	2500 for 76,000 BPSD 1900 for 50,000 BPSD	2075 for 76,000 BPSD 1550 for 50,000 BPSD

Plans for the prototype commercial size retorts include one 100' x 150' x 400' (high) and several 150' x 300' x 700' (high) retorts. Burning of the fifth retort will follow several months after completing the burn of the fourth retort, and developing, rubblizing and burning of the remaining retorts will follow, one at a time, after the burn of each preceding retort has been completed. The 100' x 150' x 400' retort is large enough to be developed by the sublevel caving method. The objectives are to quantify the behavior and properties of the rubblized material during the burn and optimize both the mining method and the retorting

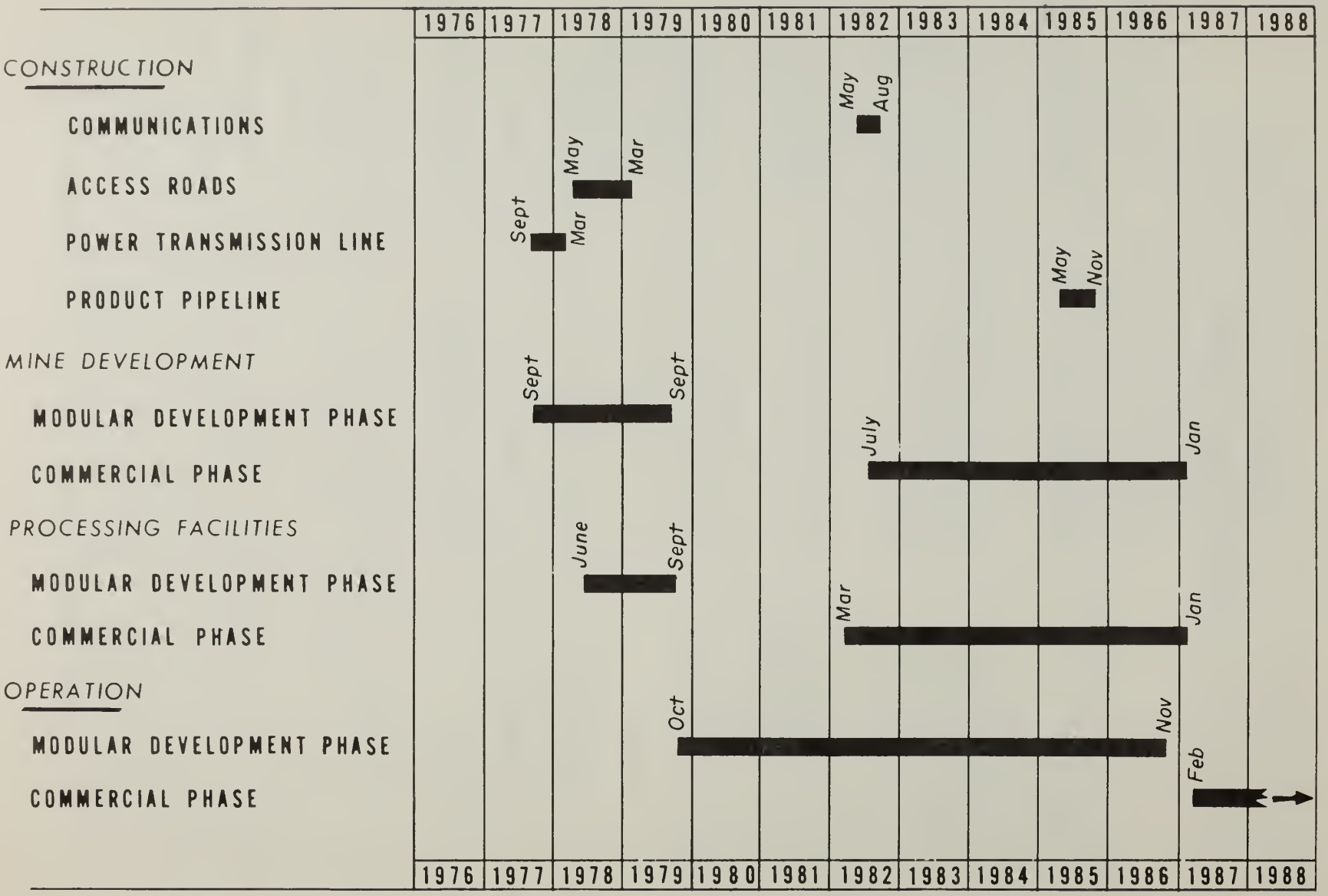


Figure 1-1-2
RBOSP CONSTRUCTION AND OPERATION SCHEDULE

method. Objectives of the remaining prototype commercial retorts are to evaluate commercial-sized retorts and continue to optimize both mining and retorting operations while allowing time for constructing the commercial facilities.

Plans for a commercial Modified In Situ retorting operation are projected for a 30-year operation utilizing 150'x300'x750' (nominal) retorts. The related production plans includes an equivalent of four retorts burning simultaneously at an average burn rate of 14 feet per day and producing shale oil at a nominal rate of 57,000 BPSD.

Access to the commercial retorts will be down vertical shafts to sublevels, then through the sublevels to the retorts. A major inclined ramp system will interconnect the sublevels and strategically positioned ore passes will connect them to a lower elevation main haulage level.

Operations will involve rubblizing retorts, transferring the resulting 20% volume of mined oil shale to a surface ore stockpile, and delivering mine water, retort exhaust gas and shale oil to surface transfer points.

More specifically, the mining operation will involve utilizing a sublevel caving technique to rubblize the retorts which includes driving sublevels with load-haul-dump (LHD) units, drilling and blasting, and then withdrawing the required tonnage with LHD units. The 20% ore removal operation will be continued as follows: (1) LHD units on each sublevel will deposit material in ore passes; (2) haulage trucks on the bottom main haulage level will recover ore from ore passes and haul to the crusher station at the shaft; and then, (3) the material will be, in sequence, crushed, hoisted, and belt conveyed to the ore stockpile.

After the chambers (retorts) have been rubblized to the correct void volume and particle size distribution, the material underground is ignited near the top of the chamber. Air, either pure or mixed with water or steam, is then injected to support combustion and to keep the burn front moving downward uniformly. The hot gases generated by com-

bustion move downward ahead of the burn zone and heat the kerogen to decomposition temperatures. This releases gas and oil in the form of vapor, mist and liquid and leaves behind retorted shale containing residual carbonaceous material referred to as coke. The oil, gas and water flow downward to the bottom of the chamber where they are pumped to the surface for processing. The coke remaining on the rock burns when the combustion zone reaches that point, providing the main source of heat for this process. Water is produced with the oil in approximately equal amounts. The sources are water originally in the rock, ground water inflow, and oxidation of hydrogen and hydrocarbons.

The products of the Modified In Situ process are processed rock, oil, water and gas. The processed rock containing a small amount of coke remains in the chamber. Most of the coke, however, is burned in the retort by the advancing combustion front. In situ retorting will produce about 57,000 BPSD of crude oil. The MIS gas is purified and is utilized in gas turbine driven electric power generation plants to provide most of the power requirements of the facility. Elemental sulfur is recovered from the gas purification operations.

The 20% volume retort material delivered to the surface will be surface retorted during the Commercial Phase in three TOSCO II retorts beginning in 1987. Each TOSCO II retort will be capable of processing 12,000 tons of oil shale to produce approximately 6,300 barrels of pipelineable shale oil daily for a total of 19,000 BPSD. A flow improver will be added to the raw shale oil produced in both in situ and surface retorting, if required, so that it can be transported by pipeline. A sulfur recovery unit will also be included.

Separate shaft sinking operations for the Modular Development Phase and Commercial Phase operations are planned. Mobilization for the Modular Development Phase shaft begins towards the end of 1977 with shaft sinking beginning in early 1978. Oil production from the first retort is scheduled to begin towards the end of 1979. Construction of the Commercial Phase

shaft will begin in mid-1982 after evaluation of the results of the burn of Retort No. 5. Commercial operations are scheduled to begin in early 1987.

Figures 1-1-3 and 1-1-4 depict the location of proposed RBOSP facilities. Retorts 1-5 in the Modular Development Phase (MDP) will be in the shaft pillar in the vicinity of the MDP service shaft. The prototype commercial retorts in this phase (Retorts 6 and up) will be developed in commercial field No. 3 immediately adjacent to the shaft pillar east boundary.

Commercial development, beginning in 1987, will commence in commercial field No. 1 adjacent to and north of the shaft pillar. Subsequently, commercial fields 2, 3 and 4 will be developed sequentially in a special pattern. This Commercial Phase is anticipated to last 30 years, at which time approximately one-half of the tract will have been developed.

Location of the disposal site for processed shale and the plant site are both on tract. Selection of Rinky Dink Gulch as the location for processed shale and development material disposal was based on the fact that it is located on the tract and is in an area of minimum drainage. Operationally, it is sufficient in size to hold the waste products and is also logistically desirable. Investigations are underway to determine if part or all of the processed shale could be injected into the spent retorts by slurrying for the purposes of (1) ground stabilization, (2) sealing the retorts against leaching by groundwater, and (3) disposal of the processed shale. Selection of the processing facility site was based on its close proximity to the mine and disposal area which will reduce acreage disturbance; the elevated topography which will enhance dispersion of stack emissions; and the relatively level terrain which will minimize disturbance.

During the first eight years of the Modular Development Phase, the development ore will be transported by truck to disposal piles just northeast of the production and service shaft pillar. This material will be contoured, covered with soil, and then revegetated. For the

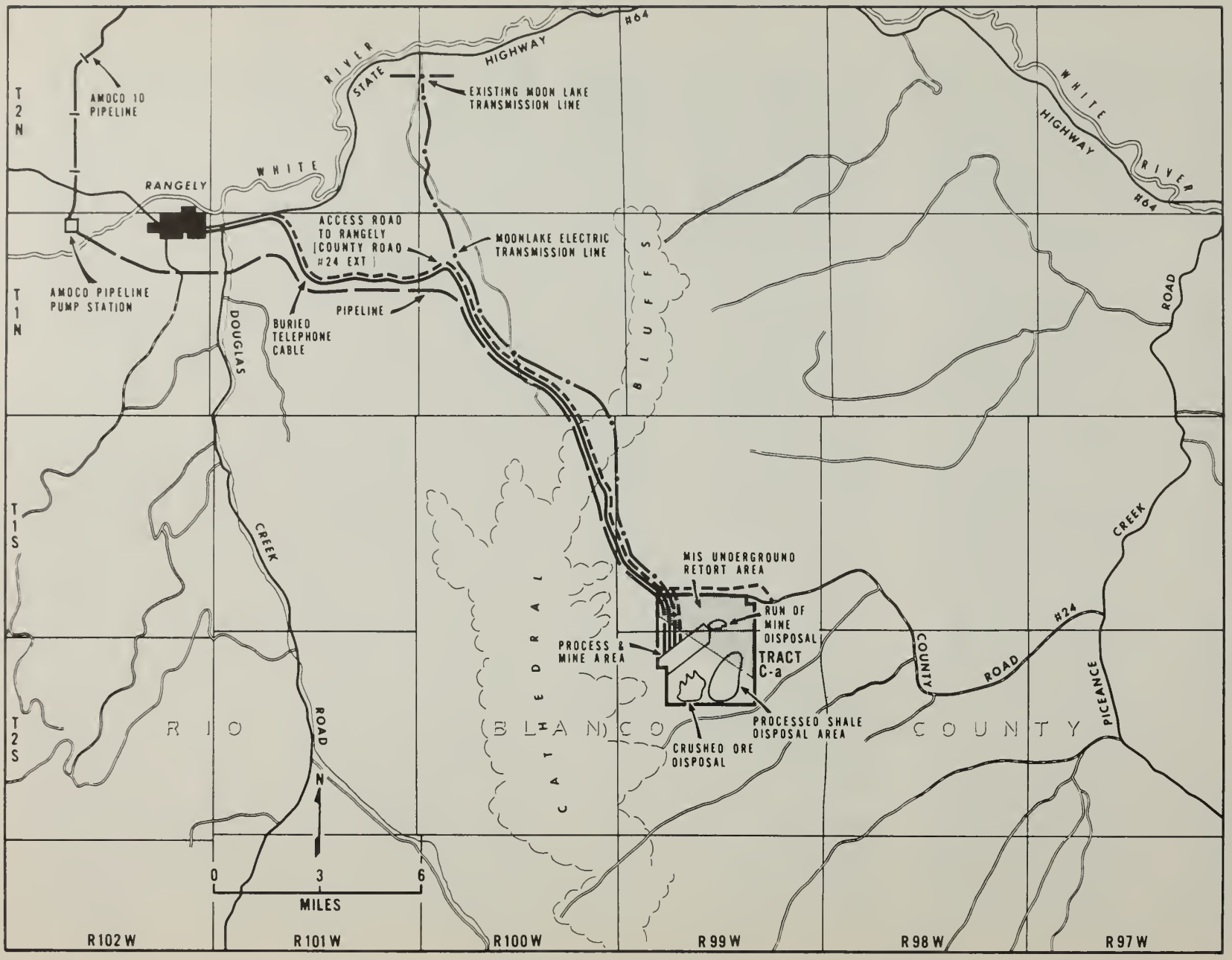


Figure 1-1-3
LOCATION OF PROSP FACILITIES

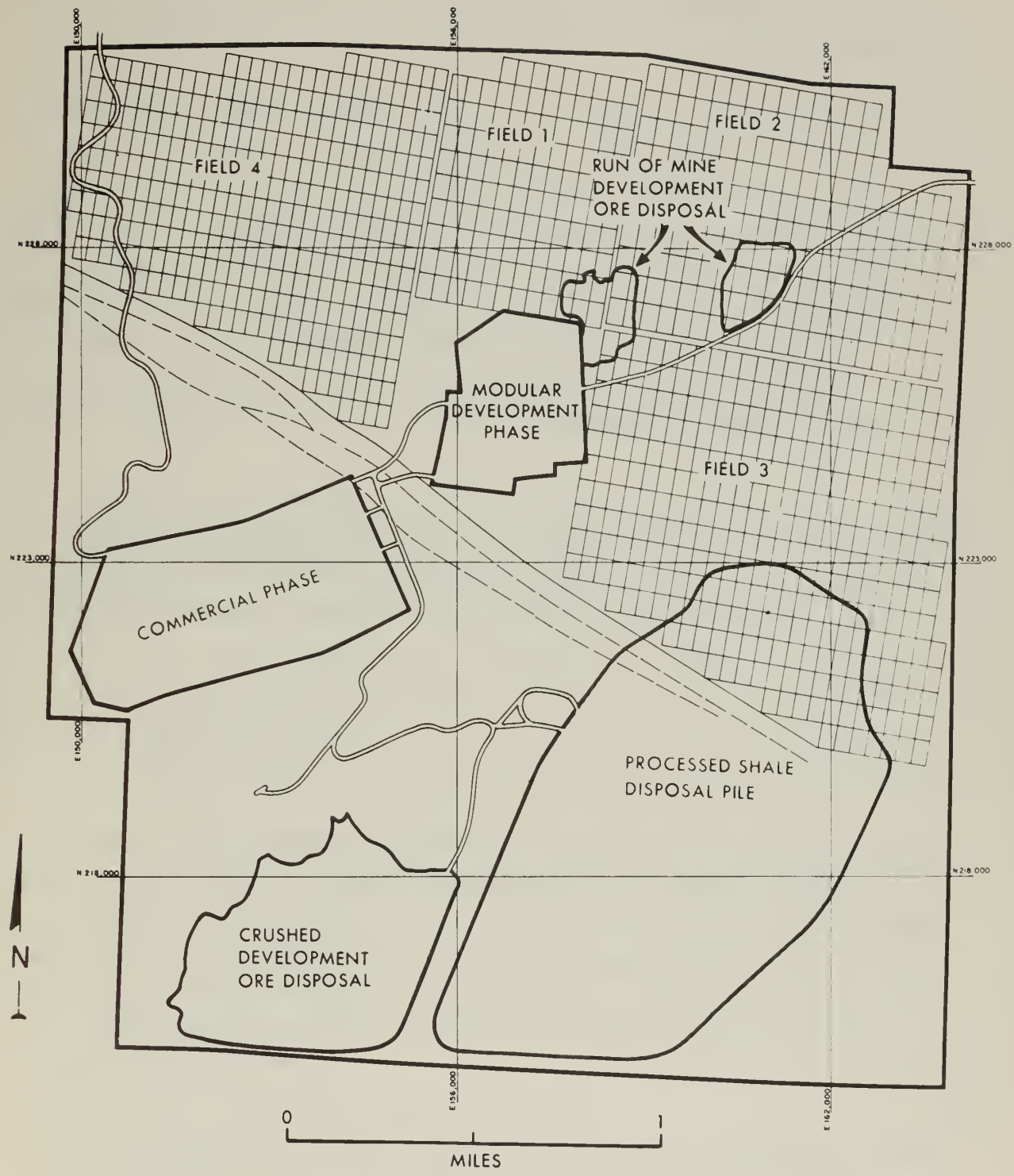


Figure 1-1-4
LOCATION OF RBOSP FACILITIES ON TRACT C-a

commercial operations, the ore from producing the 20% void volume will be crushed underground in a primary crusher, hoisted, and then belt conveyed to the plant site. After secondary crushing and retorting, the processed shale will be transported to the disposal area in Rinky Dink Gulch by belt conveyor. This conveyor system will be installed by 1985 allowing disposal of raw oil shale to the south during the large production associated with development for the Commercial Phase. This material will eventually be used to cover the processed shale. As final slopes are established on the disposal pile, the processed shale will be covered with 8 inch minus crushed material and soil obtained from the disposal area. The disposal pile will be contoured, revegetated and progressively reclaimed as operations proceed.

RBOSP's principal product, shale oil, will be transported by pipeline to Rangely, Colorado, then through an existing Amoco pipeline to other connecting carriers for ultimate delivery to refineries or markets in the West or Midwest. Flow improvers will be added to the raw shale oil, if necessary, to make it pipelineable. The by-product sulfur will be trucked from Tract C-a to rail facilities near Rifle, Colorado. An exception to this pipeline plan is during the Modular Development Phase when shale oil will be trucked to an existing refinery or markets.

Mine dewatering during the Modular Development and Commercial Phases will produce more water than is required for project needs. This excess water will be reinjected off-tract into the aquifers. Up to 1000 acre-feet/year (AFY) of groundwater will be used during the Modular Development Phase, obtained from mine seepage and/or the dewatering wells. During the Commercial Phase, approximately 2200 AFY of groundwater will be used.

Project purchased power requirements will be up to 40 megawatts (MW) during the Modular Development Phase operations and will increase to some 100 MW net during the Commercial Phase. Moon Lake Electric Association will supply electricity to Tract C-a via a 138-KV transmission line from an existing line near the White River some 20 miles north of

the tract. RBOSP will utilize the low BTU gas produced from MIS retorting to produce most of its power needs during the Commercial Phase.

Mountain Bell Telephone Company will provide communications from Rangely for commercial construction and operations. Vehicular access to Tract C-a will be via Rio Blanco County Road 24 (Ryan Gulch Road) from the east and via an extension of this road from the tract to Rangely on the west. The power transmission line, shale oil pipeline, and access road will be located, wherever possible, in a common corridor between Rangely and Tract C-a in accordance with the present BLM corridor concepts.

RBOSP employment during the two phases is shown in the graph in Figure 1-1-5.

C. Construction Activities - Mine and retort development and construction of retort feed preparation, processing, processed shale disposal, and support facilities will typically include the following steps:

- Clearing and grubbing
- Salvaging soil
- Construction staking
- Rough grading
- Distributing power and water
- Excavating for foundations and underground facilities
- Placing concrete
- Erecting buildings
- Installing machinery
- Enclosing buildings
- Finish grading
- Installing interior wiring and piping
- Testing of systems and machinery

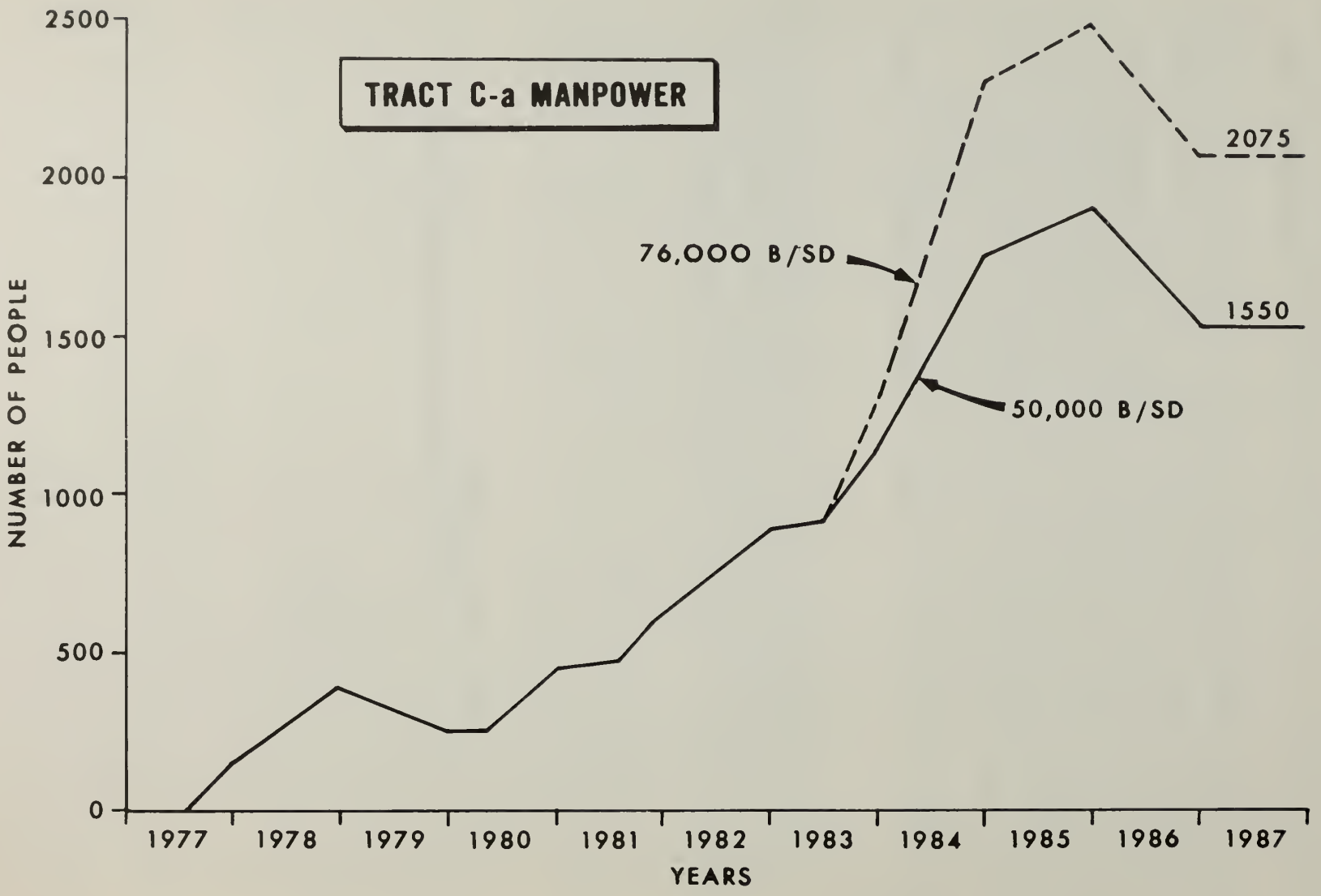


Figure 1-1-5
TRACT C-a MANPOWER

Some of the major mining equipment--underground drills and haulage equipment--may be assembled on-site at Tract C-a (above ground or underground) because of the size and weight of fully-assembled units. Similarly, some of the components in the processing facility--heaters, tanks, large diameter pressure vessels--may be field-fabricated.

Construction activities will be coordinated to minimize land disturbance and to avoid unnecessary disturbance. Vehicular traffic will be restricted to established roads, where possible.

D. Major Actions Needed Before RBOSP Can Proceed - Before RBOSP can proceed with development of Tract C-a, there are approvals and permits that must be obtained from County, local, State and Federal governments. Among these are approval of the DDP, approval of necessary rights-of-way and obtaining all necessary permits for construction and operations, which presupposes the emissions and effluents from the operation will be acceptable under State and Federal regulations.

CHAPTER 2
MINING

Modified In Situ (MIS) retorting is a method of retorting underground rooms (retorts) of rubblized oil shale in place and recovering the resulting products. Basically, the process involves accessing the oil shale deposit, developing retorts, rubblizing, extracting a portion of the rubblized oil shale, burning that portion of oil shale left in the retorts, collecting the gas, oil and water products, and delivering them to the surface.

This chapter summarizes for the planned Tract C-a Modified In Situ operation, the mining activities required to access and prepare underground retorts for burning, and develop passageways for conveying gas, oil and water products to the surface.

More specifically, mining for the MIS plan includes all activities related to shaft sinking, station and level development, development of combustion air and product separator systems, underground haulage, primary crushing, hoisting, surface haulage, mine drainage and mine ventilation.

The MIS retorting plan for Tract C-a involves a forty-year combined Modular Development Phase (MDP) and Commercial Phase operation covering about 2200 acres in the north half of Tract C-a. The oil shale included in this retorting plan lies north of the northernmost graben and between the top of the R-8 zone and the base of the R-4 zone (stratigraphic zonation of oil shale established by RBOSP).

This stratigraphic interval (top R-8 - base R-4) thickens from the west to east side of the MIS - Commercial Phase area. The beds within this area strike generally N20^{O}W and dip gently basinward to the ENE at a rate of about 200 to 350 feet per mile (2-4^{O}) except where locally disturbed by faults.

Base hydrology data for this plan includes minor surface water in the form of springs and one perennial flowing stream reach in Corral Gulch, and two deep bedrock aquifers. The upper aquifer occurs primarily in the Mahogany zone immediately below the R-8 zone and the lower aquifer occurs predominately in the R-3 zone below the R-4.

General mine arrangement includes four Commercial Phase retort fields (1-4) with a central shaft pillar; five Modular Development Phase (MDP) retorts positioned in the east portion the the shaft pillar; and additional MDP retorts located in the commercial field (No. 3) east of the shaft pillar. See Figure 1-2-1.

The Modular Development Phase for the Tract C-a Modified In Situ retorting operation is designed to provide the means of systematically and incrementally developing the operation from a small modular activity to a full-scale commercial operation.

The Commercial Phase is a culmination of MDP efforts and is designed to produce a steady daily rate of shale oil for 30 years.

The plan for the MDP consists of burning individual retorts in a sequence that allows for an evaluation of the previous burn before the next is started. Five graduated-sized small retorts and several commercial-sized retorts are scheduled to be burned during the MDP. Burning will progress in sequence from the smallest to the largest retort.

Preparation for burning the MDP retorts will be by underground mining methods. Mining will provide access to the retorts through developed openings. Subsequent rubblizing of the smaller retorts (1-4) will be accomplished by specialized drilling and blasting techniques, while rubblizing of Retort 5 and the commercial-sized retorts will be accomplished by a sublevel caving mining method.

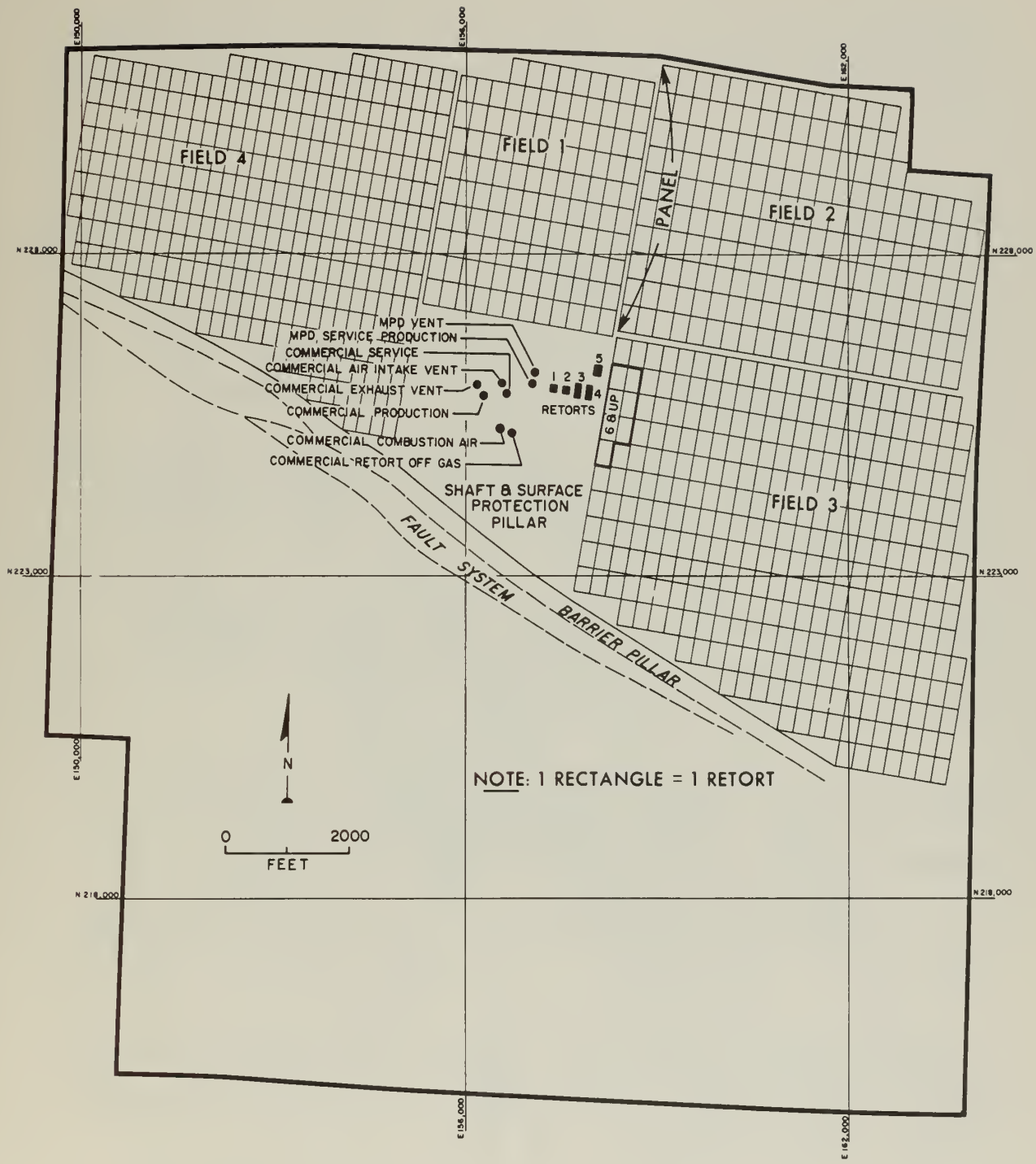


Figure 1-2-1
GENERAL TRACT LAYOUT

Mine access for the MDP includes one service-production shaft, one ventilation shaft and 10 mine levels. Four of the levels are connected to the shafts and the remainder are interconnected by ramps. See Figure 1-2-2.

Development plans for the MDP shafts include drilling the ventilation shaft and upreaming the service production shaft. The mine levels will be advanced by drilling with jumbo drills, shooting with ANFO, loading with load-haul-dump units, and hauling either with LHDs or haulage trucks (latter dependent on distance to shaft). For truck haulage, rock will be delivered to the main haulage level through rock-passes.

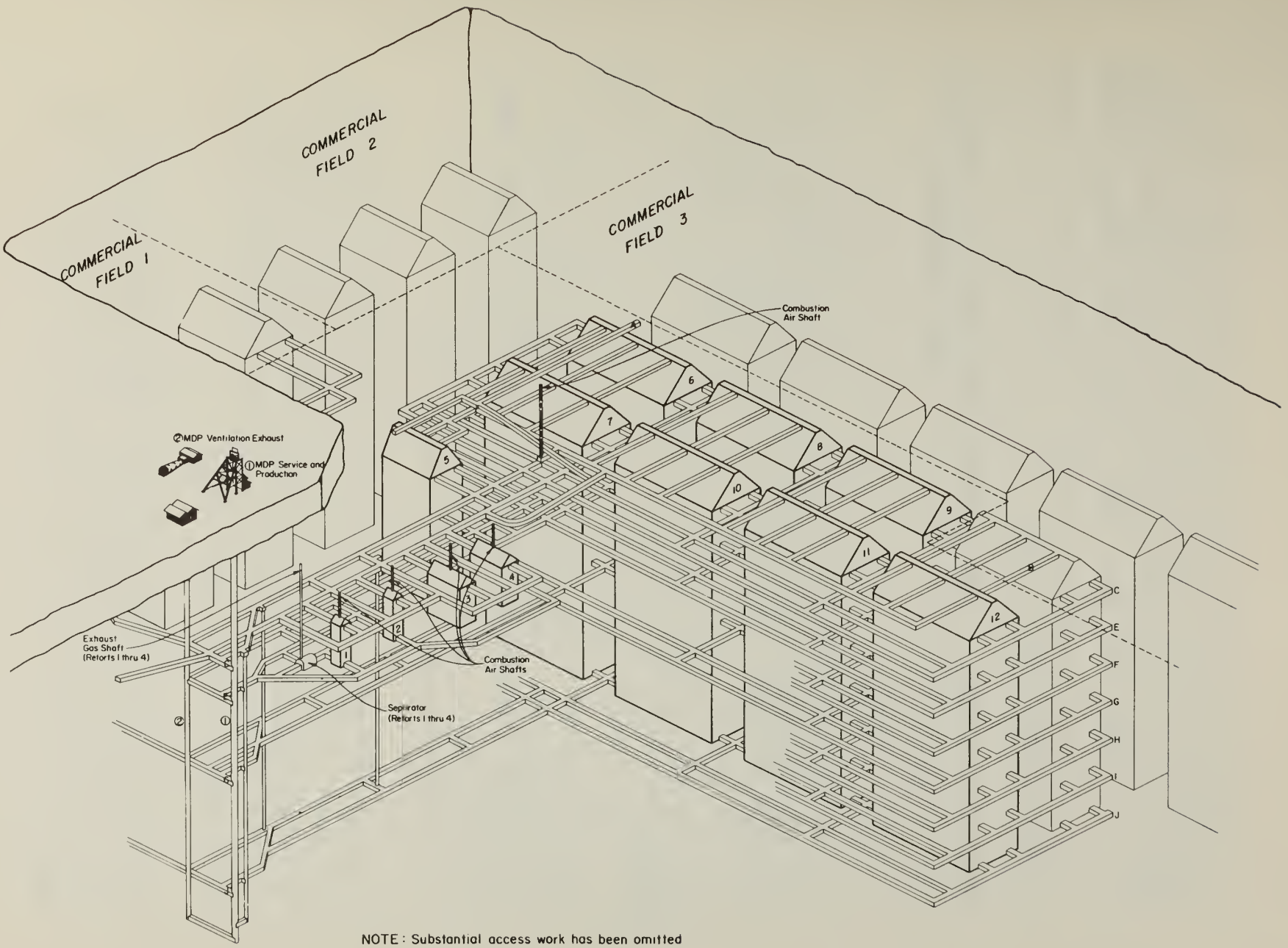
MDP retort dimensions range from 30 feet square by 140 feet high for the smallest to 150 feet wide by 300 feet long by a nominal 750 feet high for the largest.

Other MDP mine openings include several boreholes drilled from the surface, a combustion air shaft and individual separator systems for Retorts 1-4, Retort 5 and Retorts 6 and up.

Retorts 1-4 will be developed from three mining levels and will be rubblized by special drilling and blasting methods. Retort 5 will be developed from five levels and rubblized by a sublevel caving, drilling and blasting method. Retorts 6 and up will be developed from eight levels and rubblized by the same sublevel caving, drilling and blasting method.

To obtain the desired void volume, a portion of the rubblized rock will be drawn off by LHD units and delivered to the surface via rock-passes, haulage trucks, and hoisting.

The separator systems, including a collector tunnel, separator room, pump room product tunnels, will be excavated by conventional drifting methods.



NOTE: Substantial access work has been omitted in the interest of clarity.

Figure 1-2-2

MODULAR DEVELOPMENT PHASE - SCHEMATIC ACCESS LAYOUT

MDP broken rock handling includes loading at development and rubble faces with LHD units and hauling to and dumping in rock-passes, loading trucks on the main haulage level from rock passes, hauling to and dumping in a shaft storage bin at shaft station, loading skips, hoisting, dumping in bins attached to the headframe, dumping in haulage trucks, and finally, hauling to surface disposal piles.

MDP support operations include ventilation (200,000 cfm), mine drainage, power, maintenance (underground facilities), safety, communications, and service hoisting.

Plans for the Commercial Phase mining portion of the Modified In Situ retorting operation include a 30-year operation of developing and rubblizing commercial retorts. During this time an equivalent of four retorts will be burning at any given time. This 30-year operation is distributed over four individual retort fields containing a total of 932 retorts.

General mine access for the Commercial Phase mine includes 10 shafts (service, production, intake air ventilation, exhaust ventilation, combustion air, retort offgas, and four surface-to-separator-pump rooms) and 8 mining levels. Four of the levels are connected to the service shaft and the remainder are interconnected by ramps.

All commercial shafts, will be either sunk conventionally, blind bored, or upreamed. Drifting will be accomplished by drilling full-face rounds with multiboom jumbo drills, blasting with ANFO, loading and hauling with LHD's to rock-passes, loading trucks on the main haulage level from rock-passes and hauling to shaft station.

Dimensions of pillars between retorts will remain constant within a given field but will vary between fields. These pillar dimensions are based on rock mechanics data and are keyed primarily to depth of overburden.

There will be one separator system for each commercial field which consists of a collector tunnel, separator room, pump room, ventilation shaft, and return tunnels. The retort offgas shaft and oil-water return shaft (MDP ventilation shaft) are common to all four fields.

Development of the commercial retorts will be from eight levels and rubblizing will be accomplished by a sublevel caving drilling and blasting method. To achieve the desired void volume, a portion of the rubble will be withdrawn by LHDs.

Broken rock handling for the Commercial Phase is identical to MDP rock handling, except the rock will be crushed at the shaft crusher station and will be belt conveyed on the surface from the headframe bin to an ore stockpile. Dawsonite-bearing oil shale may be segregated for subsequent alumina extraction.

Support operations for the Commercial Phase include ventilation (4,000,000 cfm), mine drainage, power, maintenance (underground shops), communications and service hoisting.

For more detailed information on mining refer to Section 2, Mining.

CHAPTER 3
PROCESSING

The first processing step in the conversion of oil shale to useful hydrocarbon energy involves heating the rock to a temperature of about 900^{o} F. This heating process decomposes the high molecular weight organic material contained in the shale into smaller hydrocarbon molecules. Cooling and condensing of these vapors produces an oil product which resembles crude oil in several respects such as boiling range and hydrogen to carbon ratio. This process of heating oil shale and decomposing the contained organic material is known as retorting.

The shale oil product recovered from retorting contains waxy compounds and suspended particles of shale, both of which make the oil difficult to transport in an ambient temperature pipeline. Thus, additional processing steps, called upgrading, are required to prepare the oil for transport from Tract C-a to a refinery where the oil will be converted to marketable products. The processing equipment and support systems required for retorting and upgrading are known as the processing facility.

3.1 MODULAR DEVELOPMENT PHASE (MDP)

The MDP involves construction and operation of a series of MIS retorts of progressively increasing size. This program will culminate in the operation of commercial-size MIS retorts to demonstrate the technical and economic feasibility of this retorting technology. The processing facility includes equipment to supply air and steam to the MIS retorts and to recover the oil product.

The recovered raw shale oil is shipped by truck from Tract C-a. Gas and water from the retorts are incinerated in a thermal oxidizer system.

A flow diagram of the processing facility associated with the commercial-size MIS retorts operated during the MDP is shown in Figure 1-3-1. Air is compressed and piped to the retort together with steam or water. Products from the retort flow to an underground separator where gas is separated from oil and water. The gas flows to a central collection point aboveground, through a wet gas scrubber and then to a thermal oxidizer where the combustible components of the gas are burned. The thermal oxidizer is equipped with a flue gas scrubbing system to control atmospheric emissions.

Oil and water streams from the underground separator are pumped to aboveground settlers. Separated oil is sent to a tank for storage prior to shipment by truck from the tract. Water collected from the settlers is sent to the thermal oxidizer.

Similar equipment, except the wet gas scrubber and gas blower, of appropriate capacity will be provided for smaller MIS retorts operated during the early stages of the MDP.

The expected yields of oil and gas from a commercial-size MIS retort operated during the MDP are:

Shale Oil Product, BPSD	4000
Retort Gas Product, MMSCFD	210

The following water balance covers the disposition of water involved in the operation of a commercial-size MIS retort:

	gpm
Output	
Thermal Oxidizer Stack Gas Loss	800
Water in Flue Gas Scrubber Sludge	10
Miscellaneous Losses	40
	850

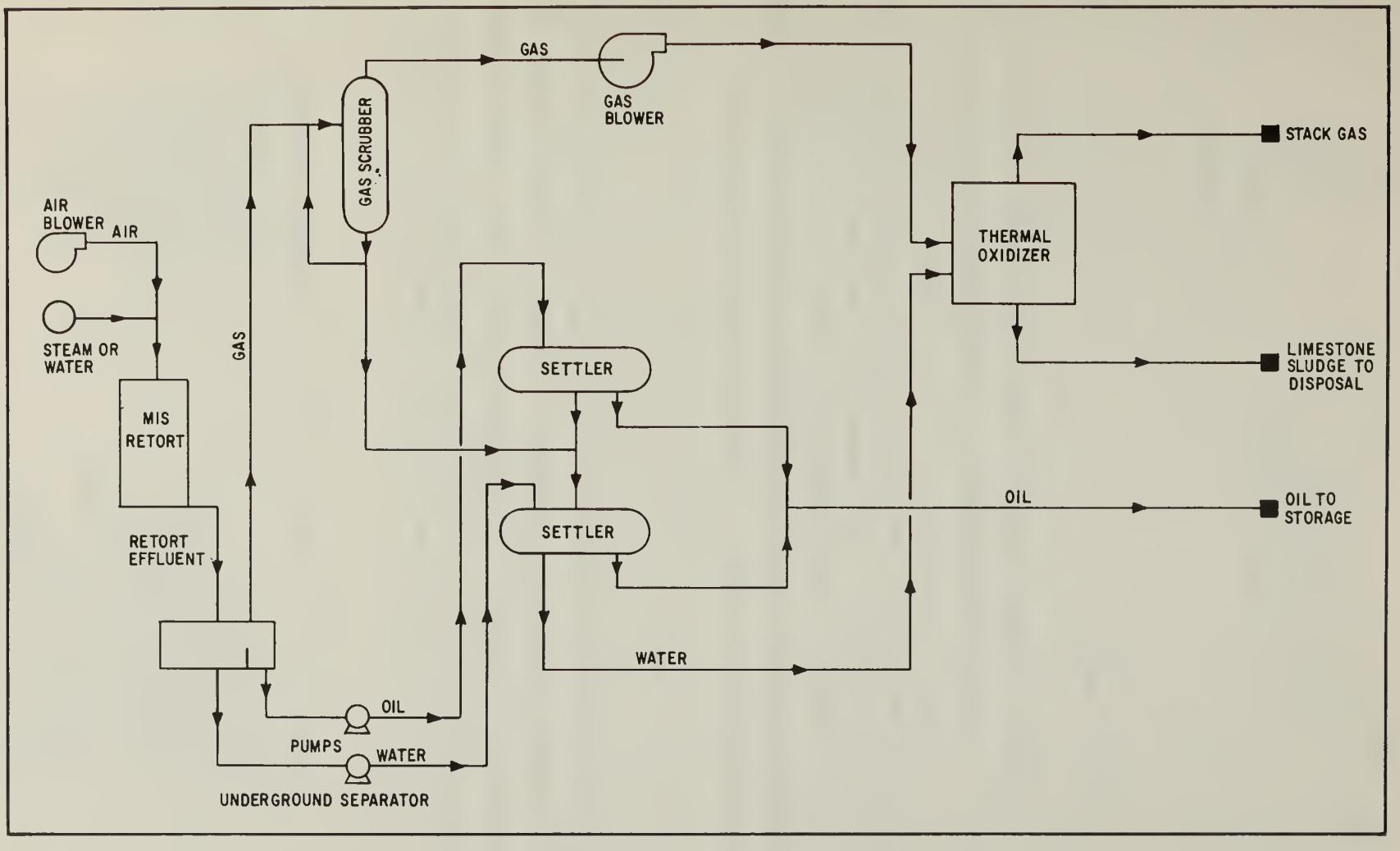


Figure 1-3-1

FLOW DIAGRAM OF MODULAR DEVELOPMENT PHASE PROCESSING FACILITY

Input	gpm
Water Intake	460
Water of Combustion	140
Retort Water and Residual Groundwater Inflow	250
	850

3.2 COMMERCIAL PHASE

The conceptually designed Commercial Phase processing facility involves retorting oil shale to produce about 76,000 BPSD of pipeline quality shale oil together with elemental sulfur by-product. The MIS retorts produce about 57,000 BPSD and the TOSCO retorts about 19,000 BPSD from surface retorting the oil shale removed to create the void space in the MIS retorts. The individual processing operations and their interrelationships described in the DDP represent the general concept of Commercial Phase processing in the light of the present state of the art.

The processing operations involve a combination of MIS and aboveground retorting of oil shale having an average Fischer Assay grade of about 23 gallons per ton (GPT) to produce oil which can be pipelined from Tract C-a in an ambient temperature pipeline. Elemental sulfur is produced as a by-product of retorting and oil recovery operations. Electric power is generated, using MIS product as fuel, to supply most of the requirements of the processing facility. Plants included in the processing facility are:

Plant	Nominal Capacity
MIS Retorting	134,000 TPSD
TOSCO II Retorting	36,000 TPSD
Oil-Gas Recovery (MIS)	47,000 BPSD
MIS Gas Purification	10,000 BPSD
Oil Recovery (TOSCO)	19,000 BPSD
Oil Fractionation (MIS)	47,000 BPSD
Oil Upgrading and Blending	76,000 BPSD
High BTU Gas Plant	30 MM SCFSD
Foul Water Stripping	--
Sulfur Recovery (TOSCO)	170 LTPSD
MIS Gas Purification (Sulfur Product)	100 LTPSD
Power Generation	230 Megawatts

Figure 1-3-2 is a block flow diagram showing the flow of major streams through the Commercial Phase processing facility. Air and steam are injected into MIS retorts which have previously been prepared by mining techniques. MIS retorting is accomplished by heating rubblized shale to retorting temperatures with hot gases formed by combustion of a portion of the oil shale. Oil, water and low BTU gas flow from the retorts to the oil-gas recovery plant. The oil is then fractionated to produce naphtha and heavy oil fractions. The gas is compressed to recover condensible hydrocarbons and is purified of sulfur compounds and used as fuel to produce electric power. Gas turbines are used to generate electricity and furnish compressed air to the MIS retorts.

Preparation of MIS retorts requires removal of about 20% of the rubblized shale to provide satisfactory retorting porosity. Shale brought to the surface is retorted in a TOSCO II retorting plant. The TOSCO oil and high BTU gas are sent to the raw oil recovery plant where gas, naphtha and heavy oil streams are separated. Gas is sent to the high BTU gas plant where a fuel gas is prepared for purification in the sulfur recovery plant.

Naphtha and heavy oil from surface and underground retorting are sent to the oil upgrading plant. Heavy oil streams are treated as required with a flow-improving chemical and then blended with naphtha and C_4 fractions to produce an oil product which can be pipelined from Tract C-a. Elemental sulfur is produced in the sulfur recovery (TOSCO) and MIS gas purification plants.

An overall material balance and selected product properties for the Commercial Phase processing are given in Table 1-3-1. A water balance showing the disposition of water is given in Table 1-3-2. The processing facility is served by various support systems including water treatment, cooling water, steam generation and electric power distribution.

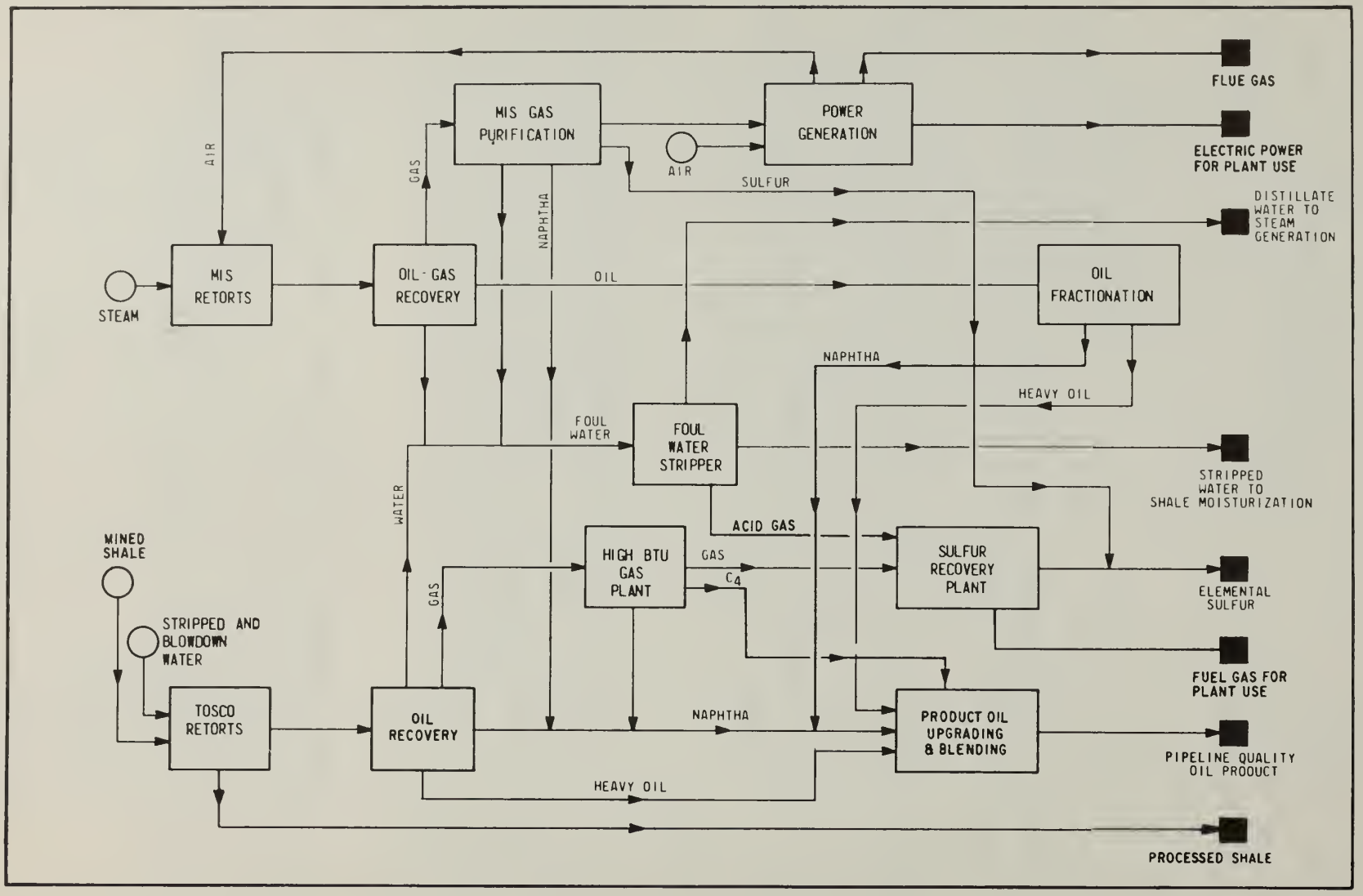


Figure 1-3-2
FLOW DIAGRAM OF COMMERCIAL PHASE PROCESSING FACILITY

Table 1-3-1

COMMERCIAL PHASE OVERALL MATERIAL BALANCE

Oil Shale	
Retorting Rate, TPSD, dry basis	170,000
Fischer Assay, GPT	23
Pipeline Quality Oil Product	
Production Rate, BPSD	76,000
Properties	
^{o}API	26
True Vapor Pressure, psia	11.2 (@ 100^{o} F)
Viscosity, SSU @ 30^{o} F	800 max
Pour Point, ^{o}F	30 max
Sulfur By-Product	
Production Rate, LTPSD	265
Moisturized Processed Shale	
Production Rate, TPSD	36,000

Table 1-3-2

COMMERCIAL PHASE WATER BALANCE

	gpm
Output	
Water on Processed Shale	840
Surface Retort Vent Gas Loss	840
Cooling Tower Loss	330
Power Generation Plant Flue Gas Loss	610
Miscellaneous Loss	130
Total Output	2,750
Input	
Water Intake	820
Water of Combustion	530
Retort Water and Residual Groundwater Inflow	1,400
Total Input	2,750

3.3 PROCESSING FACILITY LOCATION

The MDP and Commercial Phase processing facilities are located entirely within the boundaries of Tract C-a. Figure 1-3-3 is a Site Plan showing the location of these processing facilities as presently conceived. Any changes in the plan as detailed engineering proceeds is not expected to significantly alter the basic concept presented herein.

For additional detailed information on the processing facilities, refer to Section 3, Processing.

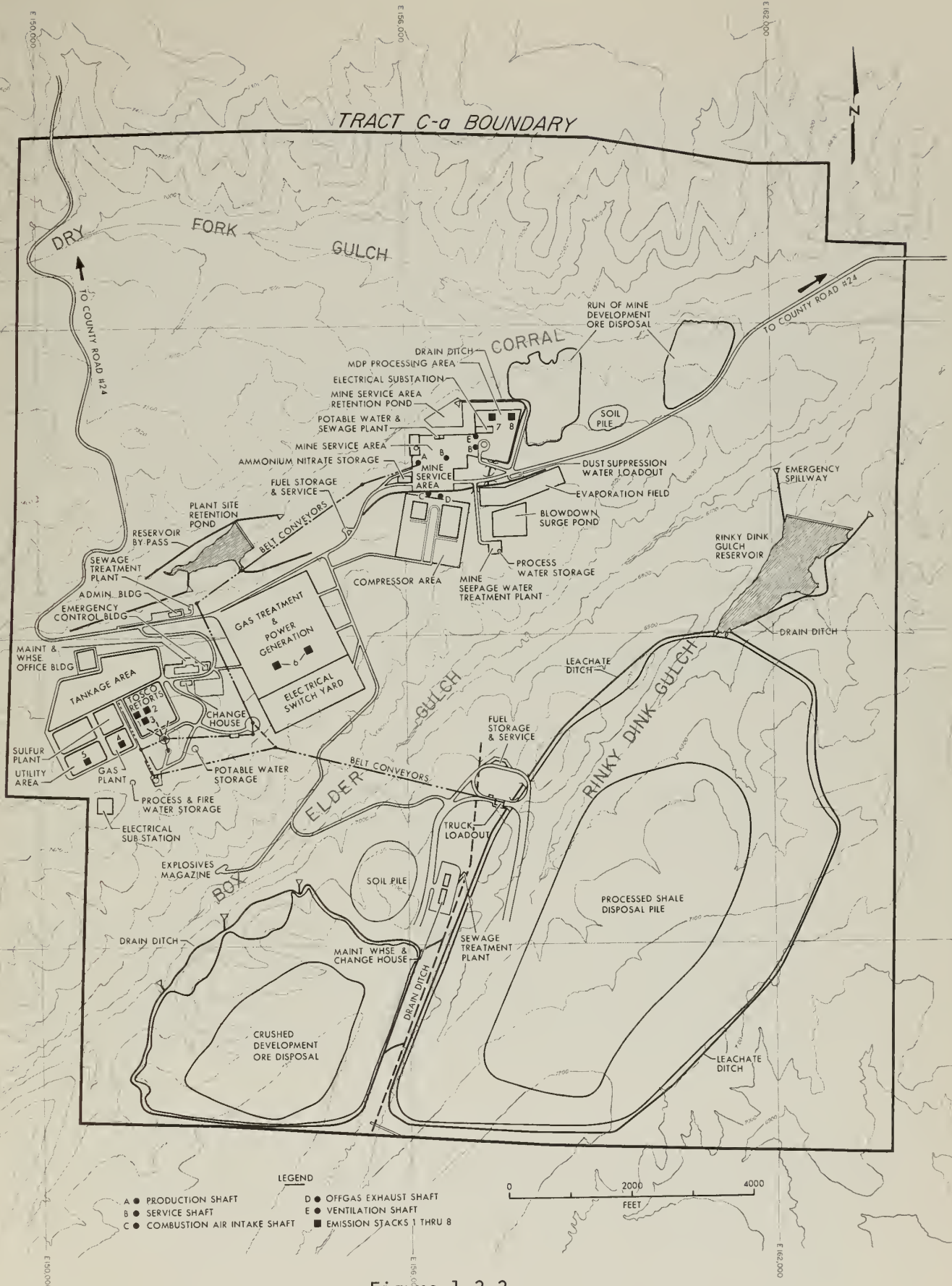


Figure 1-3-3

SITE PLAN

CHAPTER 4
PROCESSED SHALE AND DEVELOPMENT ORE DISPOSAL

4.1 PROCESSED SHALE

Development of Tract C-a requires the surface disposal of large volumes of processed shale from aboveground retorts. Selecting the most desirable disposal location requires consideration of the following criteria.

- Environmental impact.
- A site of sufficient size to contain all of the processed shale.
- Location in which processed shale could be stabilized and rehabilitated as soon as possible.
- An on-tract location that would not unduly restrict MIS retort development.
- Reasonable proximity to the surface retorts.

Rinky Dink Gulch in the southeast portion of the tract (See Figure 1-1-4) was selected as the most suitable location to satisfy these criteria.

The physical characteristics of the processed shale used to design a disposal pile were determined prior to disposal pile planning. The TOSCO II processed shale is a very fine material; screen analysis indicates that over 50 weight percent of the material will pass a 100-mesh screen.

An area of 880 acres will be required to contain the volume of processed shale produced. Disposal operations will begin by stripping and stockpiling the soil from an area that will be used initially in the disposal pile construction. Beginning in 1987, processed shale will be transported by an overland conveyor to the disposal area. The processed shale will be loaded into trucks or scrapers which will haul and dump the processed

shale in about two-foot lifts along the surface of the disposal pile. The processed shale will then be compacted and exterior surfaces sloped at 4:1. The entire processed shale pile will eventually be enclosed by crushed ore (minus 8" size). Soil will cover this crushed ore creating an artificial soil profile on the final surfaces that will aid reclamation. Total volume of compacted processed shale will be approximately 310 million cubic yards. As development of the disposal pile progresses, RBOSP will maintain an on-going program to ensure the overall stability of the disposal pile final slopes and working surfaces.

If it is determined that processed shale will be used to backfill the MIS retorts, the size of the disposal pile will be smaller. However, the methods of material handling and disposal pile construction and revegetation will be the same.

4.2 DEVELOPMENT ORE DISPOSAL

Disposal sites for development ore, run of mine (ROM) and crushed ore, from the underground retorts were selected on the following basis:

- Minimum environmental impact.
- Sites large enough to contain the development ore.
- Sites that could be rehabilitated.
- On-tract locations that would not restrict MIS retort development.
- Reasonable proximity to the mining area for ROM disposal during MDP.
- Reasonable proximity to the end of the conveyor and the processed shale disposal area for crushed development ore.

The area to the north and east of the mine service area was selected for the ROM material disposal during the early years of the MDP (See Figure 1-1-4).

An area in the southwest portion of Tract C-a was selected for the crushed development ore disposal.

Development ore is either ROM, nominal size 24 inches and under, or crushed, 8 inches and under. During the early years thru 1984, the material removed from the underground mine will be ROM size. An area of about 65 acres will be required to hold the 5 million tons of ROM material that will be produced. Disposal operations will begin by stripping and stockpiling the soil from an area that will be used initially. Material will be moved from the mine shaft by truck to the ROM disposal site. Disposal piles will be developed by rear dump trucks discharging ore at the top elevation along the slope of Corral Gulch. The exterior surfaces will be shaped to blend with the surroundings and sloped at 4:1. The surface will be covered with about 12 inches of soil and revegetated.

During 1985 and 1986, the material removed from underground will be crushed to 8-inch maximum size. An area of about 260 acres will be required to hold the 27 million tons of crushed development ore that will be produced. Disposal operations will begin by stripping and stockpiling the soil from the area that will be used initially. The crushed development ore will be moved from the mine shaft by the conveyors that will be used in the Commercial Phase to move ore to the TOSCO retorts and processed shale to the disposal area. From the end of the conveyor system, the ore will be trucked to the disposal area and handled in the same manner as the ROM material above. Reclamation will be handled in the same manner as the ROM piles except that portions of the pile, to be used in the artificial profile on the process shale pile, will not be reclaimed until the processed shale pile is completed and reclaimed.

For additional information, see Section 4, Processed Shale and Development Ore Disposal.

CHAPTER 5
SUPPORT FACILITIES

5.1 INTRODUCTION

Support facilities for the development of Tract C-a will include roads, power transmission line, water supply and distribution system, product pipeline, communications system, fuel and explosive storage, and several buildings.

The locations of most project support facilities are dictated by the locations of the major project features: the mine, the processing facility, and the development ore and processed shale disposal areas. Areal relationships among these facilities are shown in Figures 1-1-3 and 1-1-4 which also depict routes of the product pipeline, power transmission line and the Ryan Gulch and Rangely access roads.

5.2 TRANSPORTATION

The bulky machinery and equipment to be used or installed during construction, plus materials and supplies necessary for construction and operation, will originate outside the northwest Colorado area. Whatever their origin, heavy and/or bulky items will probably be shipped by rail. There is currently no rail service into the interior of the Piceance Creek basin and none is planned by RBOSP. The nearest railheads are the Denver and Rio Grande Western Railroad (D&RGW) spur line at Craig and the mainline at Rifle. Because highway distance from Rifle to Tract C-a is some 30 miles shorter than from Axial to the tract and because Rifle is on the mainline rather than a spur, the Rifle area is the logical choice as a destination for goods shipped by rail to Tract C-a. A new railroad siding will be built in the vicinity of Rifle to handle the rail traffic serving Tract C-a. RBOSP is currently in the process of

selecting an exact location for the siding. Trucks will transport goods from the siding to the tract. Goods shipped entirely by truck can reach the corridor serving Tract C-a by a number of different routes. Trucks originating in Salt Lake City or points west will likely reach the tract via Vernal and Rangely rather than swinging south through Grand Junction and Rifle. Trucks from Denver and other points east or south, which will likely constitute most of the truck traffic serving Tract C-a, will pass through Rifle on their way to the tract. Thus, Rifle will likely be a focal point for truck and rail transportation during construction and operation.

Most of the Tract C-a construction and operating personnel are expected to reside in Rangely if the Rangely access road (extension of County Road 24) is constructed. The Rangely access road will reduce the current highway distance from Rangely to Tract C-a by more than 40 miles and thus substantially reduce commuting time. For those choosing to live in Meeker or Rifle, the commuting distance will not change from what it is now.

The principal highway route serving Tract C-a will extend from Rifle on the southeast to Rangely on the northwest. The route follows State Highway 13 from Rifle to Rio Blanco then turns northwest on the Piceance Creek road (County Road 5) to County Road 24, west to the historic Ryan Gulch School, then turns northwest over the Yellow Creek-Piceance Creek divide and on west to the processing facility at Tract C-a. There, it connects with the planned extension of County Road 24 to State Highway 64 and then west to Rangely. Other roads and highways in the area will carry very little traffic directly associated with the Rio Blanco Oil Shale Project.

5.3 POWER SUPPLY

Power demand for the Rio Blanco Oil Shale Project, by year, is estimated to be as follows:

Year	Power Demand MW
1978	4
1979-81	9
1982	12
1983-86	40
1987-2016	100

Installation of power lines actually may begin in 1977, but power may be needed at the tract for mine development and construction activities prior to completion of the power lines. This power will be supplied by diesel engine driven generators. The power needed during construction will be about 4 MW in 1978. Power demand will then increase to 9 MW in 1979 when the Modular Development Phase operations begin, and will again increase to 12 MW in 1982 when expanded Modular Development Phase operations begin. In 1983-86, power demand will be about 40 MW due to construction for the Commercial Phase. Commercial Phase power demand from off-tract sources will be about 100 MW, beginning in 1987.

Tract C-a is located within the service area granted to Moon Lake Electric Association, Inc., by the Colorado Public Utilities Commission. Moon Lake is thus the exclusive distributor of electricity to the Rio Blanco Oil Shale Project.

As of January 1975, Moon Lake owned and operated a total of 331 circuit miles of 69-KV and 138-KV transmission lines with a total system load of about 60 MW. Its present generating facilities consist of two small hydroelectric plants with a combined output of 2.1 MW. The Association has historically satisfied the bulk of its system requirements by purchasing power from wholesale suppliers. Moon Lake is a member of the Intermountain Consumer Power Association, and through this association, purchased most of its power for resale during 1974 from the Colorado River Storage Project of the U. S. Bureau of Reclamation. Moon Lake is currently buying additional power from Utah Power and Light and plans to use this source to satisfy RBOSP requirements.

During the Commercial Phase, on-site power generation will supply much of the power needs with the remainder supplied by Moon Lake. Moon Lake's basic plan is to tap an existing 138-KV line near the White River approximately eight miles east of Rangely. Some 20 miles of single-circuit, 230-KV transmission line will be built between there and Tract C-a. This line will be operated at 138-KV during the Modular Development Phase. As demand requires, conversion of the line to 230-KV operation will be made. Several alternatives are being considered by Moon Lake to provide 230-KV at the White River tap point when required.

5.4 PRODUCT PIPELINE

The primary product from the Rio Blanco Oil Shale Project (pipelineable shale oil in the Commercial Phase) will be transported to Amoco's pipeline facilities near Rangely via a 26-mile, 10-inch product pipeline to be built in 1986. From there it will be transported through Amoco's existing 10-inch pipeline to other connecting carriers for ultimate delivery to refineries in the West and Midwest. During the Modular Development Phase, shale oil will be shipped by truck.

Where feasible, the pipeline will be installed immediately adjacent to the Rangely access road until the road swings north about 3-1/2 miles southeast of Rangely to connect with State Highway 64. At this point, the pipeline will continue to the west, then gradually swing to the northwest across the White River and terminate at Amoco's pump station about two miles west of Rangely. Where the pipeline forks away from the Rangely access road, it will follow other utility lines in established corridors for the remaining distance to the Amoco pump station.

The pipeline will be fed from a blending station at the Tract C-a processing facility. At the Rangely end of the pipeline, the product will be stored in two 50,000-barrel tanks in order to segregate the shale oil from other oil in Amoco's pipeline system.

Shutoff valves installed at both ends of the pipeline will be equipped with motor operators to facilitate remote and quick shut-off in the event of an emergency or accident. Other valves will be located at the Tract C-a pumping station (this will be an automatic station shutdown valve); at the head of East Spring Creek; on both sides of Douglas Creek; on both sides of the White River; and, at Amoco's Rangely delivery station. The pipeline will probably be remotely operated from Amoco's system operation at Casper, Wyoming.

5.5 WATER MANAGEMENT

A. Demand - Estimated water usages (in gallons per minute, GPM) for the Modular Development and Commercial Phases are:

Use	Modular Development Phase	Commercial Phase
Processing*	710	2220
Potable	35	60
Dust Control & Miscellaneous	220	1250
Total	965	3530

*Does not include water of combustion

Processing uses include water for boiler feed, cooling, moisturizing processed shale, operation of retort scrubbers, disposal of MIS retort water and miscellaneous uses.

B. Supply - The water supply for development of Tract C-a will come from mine dewatering systems, water produced by the MIS retorting operation and surface drainage water.

As now planned, the Modular Development Phase mine dewatering system will consist of separate wells for the upper and the lower aquifers and mine seepage. Dewatering during this phase will vary widely but should

always be in excess of requirements. The project water requirements from dewatering systems will be approximately 645 gpm or 1.4 cfs (1000 AFY).

The mine dewatering system will be continually modified with the addition of new wells and abandonment of old ones as the underground mine area grows throughout the Commercial Phase operations. Mine dewatering is expected to produce about 18,000 AFY or about 25 cfs. Water requirements from dewatering systems will be approximately 1360 gpm or 3 cfs (2200 AFY). Excess water produced from dewatering wells and mine seepage will be reinjected to reduce the overall effect on the groundwater aquifers.

C. Water Distribution at Tract C-a - The water distribution system will be continually modified and expanded as operations progress. Basically, groundwater from the mine dewatering system will be conveyed to water-storage tanks, the point of use, or to reinjection wells. A treatment plant and storage tank for providing potable water needs will be located near the mine service area to serve the entire facility. An additional storage tank will be provided in the process area for the Commercial Phase.

A small tank will be located near the mine service area for the Modular Development Phase to provide water for process uses. A large storage tank will be located near the processing facility for the Commercial Phase; water from this tank will be conveyed to points of use throughout the processing facility.

Surface runoff will be controlled throughout the project area. Diversions around the mine, processing facility and processed shale disposal pile will be provided. Surface water originating outside the project area will be diverted completely around RBOSP facilities and returned to an existing water course downstream. Surface runoff originating within the RBOSP area will be controlled and will not be released to downstream water courses unless its quality is shown to be adequate.

Ultimate design of the water distribution system on Tract C-a will reflect a continuing philosophy of zero surface discharge.

D. Water Right Acquisition - RBOSP has conducted an active program of securing rights to ground and surface water supplies needed for Tract C-a development within the prior appropriation doctrine under which Colorado administers the use of its water.

5.6 COMMUNICATIONS

Mountain Bell Telephone Company will provide telephone service to Tract C-a from Rangely. Facilities serving the tract will be either a microwave system or a buried cable installed adjacent to, and wherever possible, within the road right-of-way, thus providing good access for construction and maintenance. Enough circuits will be provided to accommodate intra-project, local and long-distance calls. Other services that will be available by virtue of the telephone system include telemetering, telecopying and data transfer.

The buried cable, if used, will follow the Rangely access road, but will not be installed until the road is completed. Thus, temporary radiotelephone facilities will be provided to handle communications during the early years of the Modular Development Phase.

5.7 STORAGE AND DISTRIBUTION OF FUEL AND OTHER SERVICE PRODUCTS

Diesel fuel, gasoline, lubricating oils, hydraulic fluid and antifreeze are required to operate mobile equipment. The estimated average annual amounts of these products (in gallons) needed for the Modular Development and Commercial Phases are summarized below:

Products	Modular Development Phase	Commercial Phase
Diesel fuel	1,055,000	5,900,000
Gasoline	46,000	135,000
Motor Oil	15,000	45,000
Other lube oils	1,500	5,000
Hydraulic fluid	18,000	52,000
Antifreeze	200	500

Diesel fuel and gasoline will be stored in buried tanks. Motor oil and other fluids will be stored in the durable containers in which they are shipped.

During the Modular Development Phase, a service station will be provided at the mine service area in conjunction with the storage tanks and delivery facilities. Additional service stations with tankage will be provided for the Commercial Phase at the processed shale disposal area equipment shop and at the processing area maintenance shop.

Waste motor oil will be collected and mixed with diesel fuel. Used antifreeze will be discharged to the sanitary sewer system. Sludge from diesel tanks, waste hydraulic fluid and other waste oils will be burned in the thermal oxidizer.

5.8 BUILDINGS

During the Modular Development Phase, most building needs will be provided by trailers or temporary buildings. The only permanent buildings will be those housing equipment that will be retained in the Commercial Phase, such as the diesel engine driven generators.

For the Commercial Phase, permanent buildings will be provided for:

- Change houses and offices.
- Administration and laboratory.

- Warehouses and maintenance shops.
- Safety and emergency facilities.
- Gate houses.
- Material storage.

With the exception of the administration building, the structures will be pre-engineered metal buildings. All buildings will be provided with heat, lighting, communications, potable water and sanitary facilities as appropriate.

5.9 EXPLOSIVES STORAGE AND HANDLING

Explosives and blasting agents, primarily ammonium nitrate and fuel oil (ANFO), will be required during the Modular Development and Commercial Phases of the project. Storage and handling will be in accordance with applicable State and Federal regulations.

Storage will be provided for about 10 days usage of blasting caps, primers and prilled ammonium nitrate. Blasting caps and primers will be stored in separate magazines located at safe distances from other facilities or areas of occupancy. Ammonium nitrate, which is not considered an explosive, will be stored in silos near the mine shaft. The ammonium nitrate will be mixed in trucks with diesel fuel to form ANFO aboveground. These trucks will be taken underground to deliver the ANFO to the working faces.

For additional information, see Section 5, Support Facilities.

CHAPTER 6

ENVIRONMENTAL PROTECTION, HEALTH & SAFETY

6.1 INTRODUCTION

Tract C-a lease stipulations require compliance with all applicable Federal, State, and local statutes, regulations and standards relating to water pollution control, water quality, air pollution control, air quality, noise control and land rehabilitation. Further requirements are to avoid, minimize, and where practicable, repair damage to the environment.

Rio Blanco Oil Shale Project is approaching the development of Tract C-a with a sincere desire to make its activities as free from environmental damage as is practicable. Toward this end, environmental interfaces have been included in all engineering work. This has permitted the development of designs and selection of equipment, alternatives and techniques that will mitigate or eliminate environmental damage.

The health, safety and environmental protection plans presented have a three fold function:

- To set forth the pollution control devices and techniques planned for the project.
- To serve as guidelines for detailed design and equipment selection.
- To serve as guidelines for construction and operation of the various facilities in a manner to mitigate environmental damage as much as practicable.

The concept of development in phases will permit the evaluation of many of the environmental quality control techniques and equipment on a full-scale basis, with time to refine these plans prior to committing vast

amounts of resources for the equipment required to implement the Commercial Phase.

To cause the least possible impact on water quality, a zero surface water discharge concept will be employed throughout the entire project. In no instance will contaminated water be discharged to the surface or groundwater courses. Natural drainages will be diverted around operating areas to avoid contamination.

Rehabilitation, including revegetation, will be a continuing program, commencing in the early years with road and power line corridors. As disposal piles are brought to final configuration, revegetation will progress as closely behind the operation as is practical.

The environmental control plans, equipment and techniques presented throughout the DDP, and in this section in particular, are based on current knowledge and technology in the field. Actual construction and operation of this project will provide some additional information on materials and processes which will permit changes and improvements to be made in the environmental control activities. RBOSP intends to take every opportunity to eliminate, minimize or mitigate any environmental degradation that may result from the oil shale development.

6.2 HEALTH AND SAFETY

The RBOSP management intends to design, construct and operate this project to provide a workplace as free as possible of hazards to the employees or the public. Therefore, the project management and staff will be fully involved in the project safety effort.

During final design and prior to the start of construction, a detailed Health and Safety program for the construction phase will be developed to include the necessary rules and codes to ensure that the facility will be built safely and in full compliance with all applicable regulations. Prior to the start of mining and processing facility operation,

a detailed Health and Safety program will be developed in a similar manner to cover all operations.

The project manager during construction and a member of management during operation will have full responsibility for executing and implementing a program of employee protection and accident prevention. A safety engineer, responsible to the project manager (construction phase) or manager (operation phase), will be employed on the project. He will be charged with inspection and investigation of work methods for safe performance, orientation of new employees in safety practices, organization of safety meetings and supervision of first-aid treatment and facilities.

A management safety committee will be formed with at least one member from each major department. The committee will meet monthly to:

- Promulgate and review safety procedures and policies.
- Discuss major accidents, pointing out the causes and how the accidents could have been avoided.
- Discuss safety hazards and suggest methods to control or eliminate them.
- Develop continuing safety programs with emphasis on problem areas.
- Review progress of work on any necessary safety improvements.

Management will be responsible for instructing each employee to recognize and avoid unsafe and hazardous conditions connected with his particular job and to be aware of and understand those safety regulations applicable to his working environment.

The project's safety and health training program will include an initial indoctrination by the safety supervisor, prework briefing and demonstration by individual supervisors, periodic safety training meetings, and follow-up field training and supervision to ensure that safety rules and regulations are fully understood and are being complied with.

In addition to a work place safety and accident prevention program, a number of special concerns need to be considered. These include exposure of employees to dust or fumes that are potentially harmful, exposure to high noise levels, handling of explosives, exposure to power cables and lines, and use of heavy machinery. Programs will be designed with these special concerns in mind in order to protect the health and safety of employees and the public.

For additional information, see Section 6, Chapter 2, Health and Safety.

6.3 FIRE PREVENTION AND CONTROL

Fire prevention and control is of particular importance in the project construction, mining and processing activities due to the large concentrations of explosives, flammable liquids and combustible material in a relatively small area. A detailed fire prevention and control plan will be developed to include preventive measures, emergency procedures and training methods. The RBOSP management will designate a member of the supervisory staff as the project fire control coordinator to be responsible for the operation of the fire prevention and control plan.

Fire prevention during construction is of particular concern because of the varied, widespread and scattered types of activities and the number of people and equipment items involved. A supply of fire-fighting tools and equipment will be furnished to each construction site. In addition, chain-saw crews and dozers working anywhere on the project will be immediately available for fire control within the project area.

Special precautions will be taken to prevent fires during activities such as blasting, welding, storage of gas and oil, and storage and handling of explosives. Open burning is not contemplated as a general practice on the project. Any burning will require specific application to and approval of the Area Oil Shale Supervisor.

The fire prevention and control plan for both the Modular Development Phase and the Commercial Phase facilities incorporates the following:

- Engineering design and plant layout to minimize the likelihood and severity of fire occurrence.
- Training program to instruct all plant personnel in normal plant operation, as well as in fire-fighting procedures and details of the fire prevention and control plan.
- Adequate fire-fighting equipment available throughout the processing facility for use by trained personnel, together with an effective communication system to coordinate fire-fighting efforts.
- Safety program incorporating regularly scheduled inspection of processing facility operating and fire-fighting equipment.

All self-propelled mobile equipment will be provided with suitable fire extinguishers. Stockpiles will be located at least 50 feet from all buildings and facilities. Accessways (at least 12 feet wide) will be maintained around and between stockpiles to permit access of fire control equipment. Combustible materials, grease, lubricants, or flammable liquids will not be allowed to accumulate in areas where they can create a fire hazard.

A personnel training program will be conducted to provide instruction in safe procedures for normal operation of the facilities, and to provide instruction in the specifics of the fire control plan and use of the fire-fighting equipment. In-plant fire teams will be organized among personnel on duty for each shift and a call-out procedure will be used to obtain additional personnel, if needed. Members of these fire teams will receive intensive and continuing training in actual fire-fighting techniques.

For additional information, see Section 6, Chapter 3, Fire Prevention and Control.

6.4 NOISE CONTROL

Construction and operation of the RBOSP mining, processing and disposal facilities will generate significant amounts of noise. Facilities will be designed and operated utilizing the best available technologies to achieve compliance with applicable laws, standards, and regulations.

Due to the remote location of Tract C-a, the general public will not be subjected to excessive noise levels. Noise exposure of workmen will be controlled by the following techniques:

- Providing sound-control enclosures.
- Providing individual protective equipment.
- Limiting exposure time.

During operations, noise levels will be monitored on a semi-annual basis or whenever a particular operation change indicates an appreciable increase in noise level.

For more detailed information on noise control, refer to Section 6, Chapter 4, Noise Control.

6.5 AIR QUALITY CONTROL

The Rio Blanco Oil Shale Project recognizes that preservation of the air quality of the Piceance Creek basin is of utmost importance. Every reasonable effort will be made to control fugitive dust, to minimize particulates and gaseous emissions and to maintain air pollutants at levels below the State and Federal standards. The best available control technology will be used. Soil stabilizers, dust retardants and surfactants, suppression systems, dry-fabric collection designs and high-efficiency wet scrubbers will be employed to maintain the air quality of the Tract C-a area.

A. Control Methods - During construction, dust will be controlled by confining traffic to specified roads and corridors, minimizing land disturbance, watering roads frequently and using dust palliatives. Straw, matting and mulch from existing vegetation will be used when required to hold soil from blowing or washing until revegetation can take place. Open burning of waste, timber, brush or construction debris will be used only as a last resort.

During operation, dust will be controlled primarily through the use of frequent sprinkling in areas of dust generation. Haul roads will be continually bladed and watered to maintain a suitable dust-free surface for the heavy haul trucks. A palliative to bind the soil particles together may be used to augment the watering program.

The crushing, conveying and stockpiling of the oil shale ore will generate a major portion of the fugitive dust and particulate emissions from the project. Three basic concepts will be used to control these emissions which are expected to occur at points in the system where transfers are made, e.g., transferring from the end of one belt to another, transferring to a pile or surge bin, or transferring from a crusher to the belt. The first is to completely cover conveyor belts to eliminate particulate emissions caused by wind. The second is the use of water sprays at selected transfer points to drop the dust back onto the belts. The third is the use of induced-draft fans and baghouse filters at some of the transfer points and the crushing buildings.

The Modular Development Phase processing facility is designed to control atmospheric emissions from the following sources:

- Boiler stack.
- Thermal oxidizer stack.

Emissions from boilers are controlled by using low sulfur fuel oil as fuel. This fuel will be trucked to the tract.

Flue gas from the oxidizer is scrubbed with an alkaline solution before release to the atmosphere to control emissions of sulfur dioxide.

The Commercial Phase processing facility is designed to control atmospheric emissions from four sources:

- Fired heaters.
- Process vents.
- Power generation.
- Thermal oxidizer.

Fuel for the processing facility is supplied by purified high BTU gas produced by TOSCO II retorting and low BTU gas produced by MIS retorting. High BTU gas is contacted with water in the raw oil recovery and high BTU gas plants where about 99% of the ammonia, which can form nitrogen oxides in combustion systems, is removed. Gas from the gas plant is desulfurized by scrubbing with Sulfinol solution to remove about 98% of the sulfur compounds contained in the untreated gas.

Gas from MIS retorting is first scrubbed with water in a venturi scrubber to remove entrained shale dust and then compressed to condense hydrocarbon vapors, water, and about 90% of the ammonia contained in the gas. The compressed gas is then treated to remove hydrogen sulfide and carbonyl sulfide. The overall removal of sulfur compounds and ammonia from the MIS gas is about 98% and 90%, respectively.

The important process stacks are located in the TOSCO II retorting plant and in the power generation plant. The preheat systems of the TOSCO II plant are fired by purified high BTU gas and low BTU gas. Flue gases from the preheating systems are scrubbed in high energy venturi scrubbers prior to release to the atmosphere. Caustic is injected into the wet scrubbers to remove sulfur dioxide from the flue gases down to an expected concentration of 10 ppmv. The TOSCO II preheat system contains an incinerator to remove 90 to 95% of the hydrocarbon vapors contained in the flue gas.

Flue gases from the ball circulation and shale moisturizing systems of the TOSCO II plant are also scrubbed in high energy venturi scrubbers before release to the atmosphere. Entrained shale dust is removed from the flue gases in these scrubbers.

Control of emissions from the power generation plant stacks is accomplished by the use of purified fuel gas prepared from raw gas produced by the MIS retorting operations.

Water recovered from the processing operations is stripped with steam to remove dissolved hydrogen sulfide and ammonia. Gas from the stripping operation is sent to the sulfur recovery plant where hydrogen sulfide is converted to elemental sulfur and most of the ammonia is converted to molecular nitrogen.

The approximate hydrogen sulfide concentration in the Commercial Phase fuel gases is 10 ppmv for both purified MIS gas and purified high BTU gas. The limit imposed by Colorado Regulation 6 is 150 ppmv of hydrogen sulfide.

Hydrocarbon emissions from oil storage tanks in the Commercial Phase processing facility are controlled by using floating roof tanks for the more volatile liquids.

Particulate control in the processed shale and development ore disposal areas will be by:

- Frequent sprinkling of haul roads.
- Compaction of material as it is distributed.
- Maintaining proper moisture content, while the material is being hauled, deposited, compacted, shaped and revegetated.
- Avoidance of inactive disposal areas by vehicular traffic.
- Establishment of vegetation (temporary and permanent) as soon as possible.

- Use of dust suppression systems at transfer points and stacking booms (during Commercial Phase).

Fugitive dust and particulate emission control techniques for the construction and erection of the support facilities will be similar to those described earlier for the construction of the mine and processing facility. The support facilities will include office buildings, shops, water retention ponds, water, oil and sewage pipelines, electric transmission lines and power distribution facilities. Minimizing land disturbance, frequent watering and prompt revegetation are the key techniques for dust control for both the Modular Development and Commercial Phases.

B. Modeling - An air quality modeling effort was performed to assess the impact of the Modular Development Phase and the Commercial Phase. This study involved analysis of elevated stack emissions of pollutants, fugitive dust emissions, materials handling emissions and storage tank emissions. The initial effort was directed toward identifying a baseline year wherein both onsite surface and upper air data and offsite (Grand Junction) upper air meteorological data were available. In developing the procedure to merge the onsite and offsite data, the available onsite upper air data were compared to the merged data set to ensure compatibility between the observed and merged data. Wind roses and joint frequency distributions of wind speed, wind direction and stability class were developed to provide the information on types of dispersion conditions frequently encountered at the site.

An EPA developed dispersion model, CRSTER, was modified to be compatible with the EPA Valley model (C9M3D) method of treating plume behavior under stable, neutral and unstable atmospheric conditions. The modified CRSTER was used to predict annual average and 24-hr. average pollutant concentrations at specified downwind distances from the sources for both the Modular Development and Commercial Phases. The five days of highest pollutant concentrations for SO_2 and particulates as identified by the CRSTR runs were then examined in greater detail using more sophisticated

techniques embodied in the AQPUF2 computer model. Due to differences in the method of treating plume behavior, especially with the ability to track a meandering plume, the short-term pollutant concentrations predicted by AQPUF2 were substantially lower than those predicted by CRSTER for each of the days examined. A similar analysis was performed for hydrocarbon emissions except that the period for which concentrations were predicted was restricted to 6 a.m. to 9 a.m. as required by the EPA guideline on hydrocarbons. Since the 6 a.m. to 9 a.m. period is generally a time when little or no photochemical reactions occur (EPA, 1977) for hydrocarbons, no half life was postulated for this pollutant. Fumigation conditions were examined separately wherein a worst-case assumption including superposition of plumes was addressed. In all cases, the predicted concentrations were less than those predicted by AQPUF2. Except for the annual average concentrations, the predicted concentrations were less than the Colorado Category I increments. In all cases, Federal Class II "no-significant deterioration" regulations and National Ambient Air Quality Standards (NAAQS) were met by the predicted concentrations for elevated releases. With proper controls, fugitive and materials handling operations should allow compliance with the standards.

The projected impacts on air quality from stack releases are summarized and compared with applicable standards in Tables 1-6-1 and 1-6-2. Compliance is indicated with the exception of the annual average SO_2 increment which exceeds the Colorado Category I Standard. The calculated effects presented in these tables do not include low-level and fugitive particulates emissions and SO and NO_x emissions from the mine ventilation system. These are handled by different techniques and, along with the elevated releases, are discussed in detail in Section 6, Chapter 5. It is expected that the facilities will comply with all applicable regulations, excepting the Colorado Category I Standard for SO_2. Federal and State emission standards will be met.

The potential impact of salt deposition from the mechanical draft wet cooling tower proposed for the Commercial Phase was assessed. Conservative assumptions were made to ensure that assessment of the maximum

Table 1-6-1

COMPARISON OF MODELING RESULTS WITH APPLICABLE STANDARDS FOR MODULAR DEVELOPMENT PHASE OPERATION

Applicable Standard	Emission	Averaging Time	Standard Limit ($\mu g/m^3$)	Maximum Predicted Off-Site Increment Due to Development ($\mu g/m^3$)	Predicted Off-Site Value ($\mu g/m^3$)
State - Category I					
Max. allowable increment	SO_2	Annual	3	3.2	NA
		24-hour	15	5	NA
		3-hour	75	30	NA
Federal - Class II					
Max. allowable increment	SO_2	Annual	15	3.2	NA
		24-hour	100	5	NA
		3-hour	700	30	NA
	Particulates	Annual*	10*	0.3	NA
		24-hour	30	1.0	NA
Colorado Ambient Air Quality Standard	Particulates	Annual	45	0.3	9
		24-hour	150	1.0	10
National Ambient Air Quality Standards					
Primary	SO_2	Annual	80	3.2	8.4
		24-hour	365	5	10.2
Secondary	SO_2	3-hour	1300	30	35.2
Primary	NO_2	Annual	100	6	8
Primary	Particulates	Annual	75	0.3**	9
		24-hour	260*	1.0	10
Secondary	Particulates	Annual	60	0.3**	9
		24-hour	150	1.0	10
Primary	NMHC	3-hour (6-9 AM)	160	0.3	65

* Geometric Mean

** Arithmetic Average

NA - Not Applicable

Table 1-6-2

COMPARISON OF MODELING RESULTS WITH APPLICABLE STANDARDS
COMMERCIAL PHASE OPERATIONS - MIS

Applicable Standard	Emission	Averaging Time	Standard Limit ($\mu g/m^3$)	Maximum Predicted Off-Site Increment Due to Development ($\mu g/m^3$)	Predicted Off-Site Value ($\mu g/m^3$)
State - Category II					
Max. allowable Increment	SO_2	Annual	15	2.7	NA
		24-hour	100	3	NA
		3-hour	700	20	NA
Federal - Class II					
Max. allowable Increment	SO_2	Annual	15	2.7	NA
		24-hour	100	3	NA
		3-hour	700	20	NA
	Particulates	Annual*	10	3**	NA
		24-hour	30	3	NA
Colorado Ambient Air Quality Standard	Particulates	Annual**	45	3**	12
		24-hour	150	3	12
National Ambient Air Quality Standards					
Primary	SO_2	Annual*	80	2.7	8
		24-hour	365	3	8
Secondary	SO_2	3-hour	1300	20	25
Primary	NO_2	Annual*	100	11	13
Primary	Particulates	Annual*	75	3**	12
		24-hour	260	3	12
Secondary	Particulates	Annual*	60	3**	12
		24-hour	150	3	12
Primary	NMHC	3-hour (6-9 AM)	160	25	90

* Geometric Mean
** Arithmetic Average
NA-Not Applicable

impact was considered. The maximum impact was predicted to occur within 100 m of the cooling towers with negligible impact occurring beyond 1.65 km of the towers.

For additional information, see Section 6, Chapter 5, Air Quality Control.

6.6 WATER QUALITY CONTROL

The water quality control plan to be employed in developing Tract C-a is illustrated schematically in Figures 1-6-1 and 1-6-2. The system is an adaptation of the American Petroleum Institute's zero discharge water concept. In RBOSP's case, water is planned to be used for process, potable water and dust control needs. Any excess will be reinjected into the appropriate aquifer off the tract or evaporated to the atmosphere.

The system will be designed to control surface runoff water, mine dewatering and the processing of waste waters. Surface water originating outside the Tract C-a project area will be diverted around RBOSP facilities. Surface water originating within the project area will be controlled by a series of ditches and retention dams and either recycled or allowed to evaporate.

From a water control standpoint, RBOSP's processing facility will be closely akin to typical U. S. refineries. Refinery operators are now quite experienced in controlling water quality, and application of the zero discharge concept in a shale oil processing facility will be a relatively small step from conventional refinery practice. The other principal source of water effluent from the complex is the mine. In this respect, however, RBOSP will be able to not only control mine water but to put part of it to beneficial use as well. Water developed in the mine dewatering operation will be of sufficient quality to permit its use in all project activities. Some water will be treated to provide potable water supplies where needed and some will be used for processing

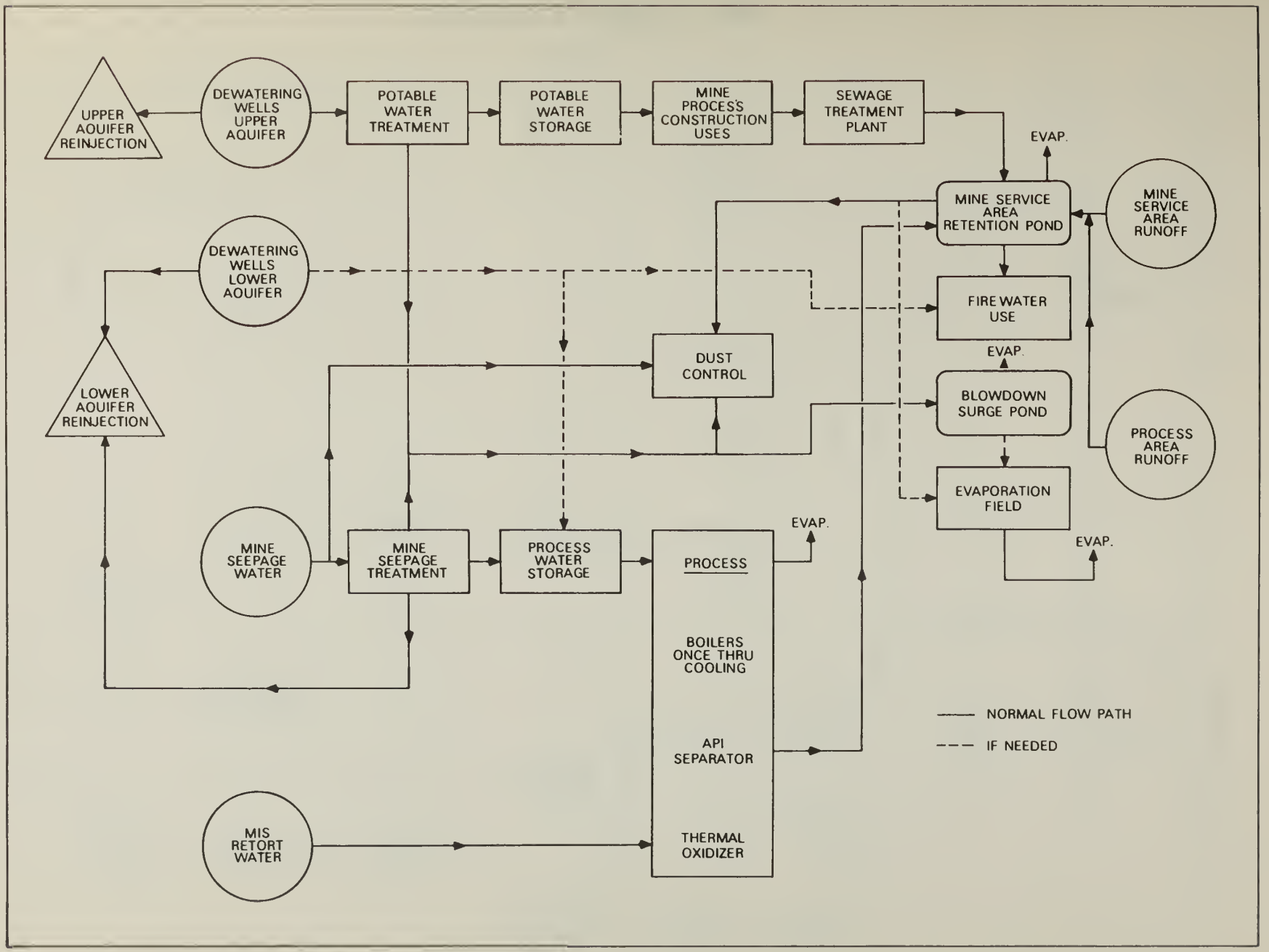


Figure 1-6-1

WATER FLOW - MODLUAR DEVELOPMENT PHASE

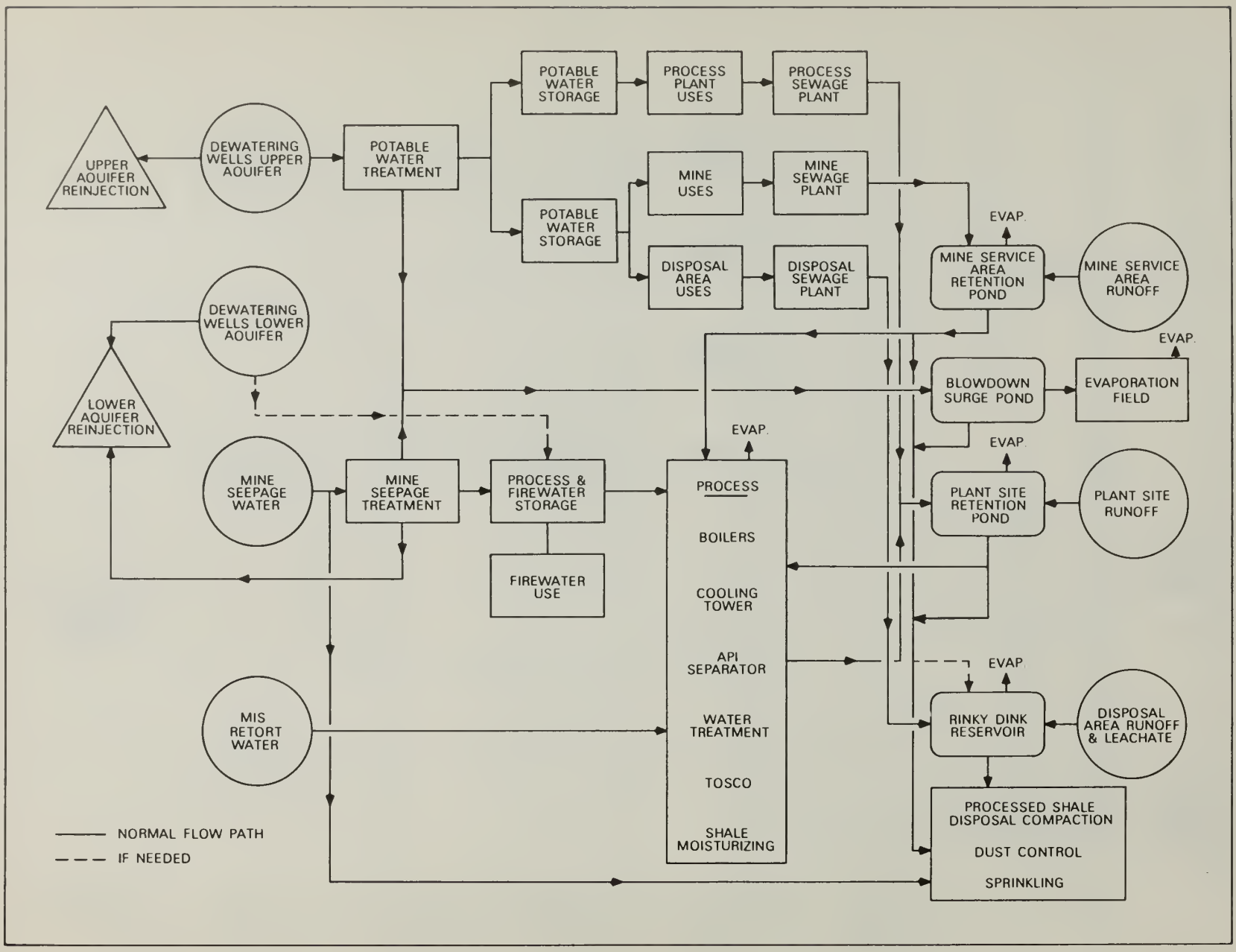


Figure 1-6-2

WATER FLOW - COMMERCIAL PHASE

needs and dust control. Most of the groundwater from beneath Tract C-a will be reinjected off the tract to reduce the effect on the aquifer system.

For additional information, see Section 6, Chapter 6, Water Quality Control.

6.7 OIL AND HAZARDOUS MATERIAL CONTROL

The oil and hazardous material control plan has been formulated recognizing that the best control plan is prevention of spills through proper design of storage, handling and transporting facilities. However, a spill contingency plan will be implemented during all phases of the project, establishing procedures to be followed to minimize damages in the event of accidental spills.

This spill contingency plan includes procedures for notification, containment, repair and cleanup of spills. The primary objective is to minimize, as far as practicable, any damage from a spill to persons, property, flora and fauna.

The layout and construction of tanks, valves, piping and appurtenances will be designed to minimize the possibility of spillage. Tanks will be enclosed by dikes designed to form spill-containment basins. The drainage from these diked areas will enter the processing facility storm drainage system and pass through an API oil separator. Catchments will be constructed in any natural drainages immediately downhill from the oil storage facilities so that should any oil find its way outside containment facilities, it can easily be controlled before it reaches a water course.

Contingency plans for the MIS underground oil/water pump room will cover design (grading, emergency equipment and facilities, control and warning systems, etc.), operating guidelines and spill response guidelines.

A detailed spill contingency plan will be developed for both nontransportation and transportation-related facilities. This plan will include procedures in the event of a spill detection and will include procedures for system shutdown, notification, reporting to Federal and State agencies, internal reporting, containment of the spill, removal of spilled material, and cleanup and restoration of the contaminated site.

For additional details, see Section 6, Chapter 7, Oil and Hazardous Material Control.

6.8 LAND REHABILITATION AND EROSION CONTROL

The objectives of the land rehabilitation program are to reclaim disturbed areas by returning them to a state that does not contribute to environmental deterioration and is consistent with surrounding aesthetic values. The overall concept of rehabilitation efforts for the project includes numerous problems and considerations dealing with mining, access, plant sites, parking lots, conveyor corridors, access roads, pipelines, etc. The principal elements considered are site preparation, erosion control and revegetation.

Table 1-6-3 shows estimates of the yearly disturbed surface areas and areas ready for rehabilitation for the operation. The Rangely access road, power line and telephone line are excluded because they will be constructed and rehabilitated by other entities; i.e., Rio Blanco County, Moon Lake Electric and Mountain Bell.

Site preparation, or the shaping and grading of areas being rehabilitated, is controlled by three primary environmental concerns: erosion control, aesthetics and the plant species to be supported. One additional factor influencing the rehabilitation work is the method selected for constructing an artificial soil profile on the processed shale disposal pile to facilitate revegetation.

Table 1-6-3

ESTIMATED ACREAGES OF LAND SCHEDULED TO BE DISTURBED AND REVEGETATED ON TRACT C-a

DISTURBED

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987-1991	1992-1996	1997-2001	2002-2006	2007-2011	2012-2016	TOTAL
Mine and Plant Sites	34				26	218										278
Run of Mine Disposal Area	65															65
Crushed Ore Disposal							130	130								260
Corridors	100	12			21	39				104						276
Processed Shale Disposal Pile									70	320	210	40	240			880
	199	12			47	257	130	130	70	424	210	40	240			1759

RECLAIMED

Run of Mine Disposal Area						15	20	30								65
Crushed Ore Disposal									200						60	260
Corridors		80	12			21	32			104						249
Processed Shale Disposal Pile											20	215	215	215	215	880
		80	12			36	52	30	200	104	20	215	215	215	275	1454

Soil excavated for roadway construction operations will be stockpiled in selected areas along the alignment for covering cut-and-fill slopes. Soil excavated from the mine service area will be stockpiled for covering the processed shale or development ore. The soil in the disposal area will also be excavated and stockpiled in an area where it can be reused later.

At the mine site, plant site and development ore disposal areas, the initial stripping will be about 100 acres. This material will be stockpiled and used as required. At that time, nutrients will probably be added to restore fertility in the soil. Additional stripped soil will be transported directly onto the development ore and processed shale piles as they reach final configuration, thereby eliminating the loss of biological and organic matter inherent in any long-term stockpiling process.

The soluble salts in the processed shale, if uninhibited, may migrate by capillary action to the surface during the summer months. Continuous maintenance activity in the form of leaching and irrigation would be required to successfully revegetate processed shale with only the small amount of soil available.

To avoid the necessity for extensive leaching of salts from the surface of the processed shale pile, an artificial soil profile will be developed. It will consist of a layer of soil underlain by a layer of crushed rock to prevent capillary movements of moisture from the processed shale upward toward the root zone. Upward moisture migration in the liquid phase is not anticipated across the rock layer. However, the rock layer will not interfere with the movement of small amounts of moisture in the vapor phase. It is anticipated that sufficient soil and soil-like material will be available to apply a 12-inch (30 cm) layer over the entire surface of the processed shale pile.

Slope roughening practices, such as scarification and furrowing slopes along the contour, will be used to decrease runoff, as well as to slow

the water movement. These practices reduce the ability of moving water to detach soil particles and transport sediments. Some of the proposed practices include:

- Slope roughening by scarification along the contour of a graded slope. The grooves spread the runoff horizontally, slow its movement downslope and increase the infiltration rate. Roughening is also beneficial in the establishment of vegetation on a graded area. This practice also increases moisture retention and loosens the soil in the plants' root zone. The horizontal grooves retain soil additives, seeds and mulch that might otherwise be washed down the slope.
- Operating a bulldozer up and down a graded slope. This practice is referred to as "tracking" and is more adaptable to steep slopes than scarification. Tracking does not loosen the soil as much as scarification, and the resulting compacted soil may be more effective on long or steep slopes exposed to high intensity rainfall.
- Developing pockets on slopes at varying intervals.

Selective spreading of individual large rocks may be included in this treatment to provide energy dissipation and shade for new plants. The rocks will also break up regular structural lines and improve the appearance.

Facilities will be provided to drain interception ditches and benches, and to direct the flow of water into erosion resistant areas or into specially designed channels. As required, a number of special disposal structures will be used including drain pipes, down drains, chutes and flumes. These disposal structures will be designed to handle the water and sediments that occur as a result of an unusually heavy downpour on bare soil areas. They will be designed for both permanent and temporary use.

Water bars and breaks will be constructed to divert water from unsurfaced roadways into natural drainages. To keep flows in road ditch sections

from reaching dangerous proportions, cross drains will be installed in addition to regular drains.

Seeding and planting operations are restricted seasonally and slopes constructed between seasons will be vulnerable to erosion, therefore, temporary erosion control measures will be provided as required at all sites where grading has been done and revegetation has not been completed. Shielding and/or protecting the soil can be accomplished in different ways. A wide variety of products is available commercially and some materials can be found locally.

Choosing the best cover material is a matter of convenience, cost, ultimate purpose and effectiveness. When the cover material is applied as an initial step in revegetation, it should also have good mulching characteristics.

RBOSP will initiate a reclamation program to reclaim all areas disturbed on Tract C-a in accordance with lease stipulations. The processed shale and development ore disposal piles represent the most difficult revegetation task since.they exhibit chemical and physical properties foreign to the surrounding area. These areas will require greater effort to achieve successful revegetation. The available technology appropriate for revegetation on Tract C-a seems sufficient to insure the likelihood of successful revegetation in all disturbed areas. Aspects of technology considered include: oil shale and processed shale characteristics, seed-bed preparation, seeding, mulch, fertilizer, biotic influences, management and revegetation schedule.

In 1975, RBOSP initiated an experimental revegetation program to investigate problems specific to revegetating disposal piles on Tract C-a. This three-year program consisted of three successive fall plantings beginning in the fall of 1975. Two sites (approximately 2-1/2 acres each) were planted in 1975 and one additional site was planted in 1976. The 1975 plantings were carried out on a soil substrate disturbed to a 3-foot depth to simulate the artifical soil profile proposed for the

disposal piles. The 1976 plantings were designed to test the growth of plants over an artificial soil profile underlain by processed shale. These studies investigated the plant species best adapted to the environmental conditions existing in the Piceance Creek basin when sown in a composite mixture; optimum period for fertilization; most effective mulch for plant establishment and erosion control; and effect of aspect on revegetation success. Plant response will be measured by quantitative parameters which include density, biomass and percent cover. These data will allow statistical analyses to determine the effects of the applied treatments.

The revegetation experimental program represents the initial step in the formulation of a successful revegetation plan for Tract C-a. The experimental results will provide a specific data base from which to evaluate and modify current methodology to further insure successful revegetation on Tract C-a.

For additional information, see Section 6, Chapter 8, Land Rehabilitation and Erosion Control.

6.9 SOLID WASTE CONTROL

The solid waste control plan has been developed for the disposal of solid wastes, excluding processed shale and development ore, which are produced during the construction and operation phases of the project. These solid wastes include process (water and gas treatment wastes and catalysts) and nonprocess (paper, wood, metal, etc.) related waste.

To the extent possible, an effort will be made to recycle nonprocess solid wastes. Nonrecyclable waste will be collected and transported to an approved sanitary landfill. Present planning contemplates that the solid waste disposal during the Modular Development Phase will be in existing approved sanitary landfills. During the Commercial Phase, solid waste disposal will be conducted at the same location as the

processed shale disposal. When processed shale disposal commences, solid waste disposal trenches will be constructed within the compacted processed shale. This method will minimize the land disturbed for the actual disposal, eliminate the need for construction and maintenance of separate access roads and storm diversion facilities, and require less equipment, fuel and manpower.

The principal solid wastes produced in the Modular Development Phase facility are spent zeolite water-softening resins, lime sludge from the water treatment system and lime sludge from the gas desulfurizing system.

In addition to lime sludge and spent zeolites from the water treatment system, the Commercial Phase processing facility will generate a certain amount of spent catalysts from sulfur plants. Spent zeolites and lime sludge will be disposed of in the processed shale disposal pile. The spent catalysts, which will not contain arsenic, will be recycled.

For additional information, see Section 6, Chapter 9, Solid Waste Control.

6.10 AESTHETICS

The principal aesthetic value of Tract C-a and its environs is the landscape, which is characterized by rolling hills and flat-topped ridges with steep to moderately sloping canyon walls dropping 100 to 300 feet into narrow, flat-bottomed valleys. Aesthetic values were considered in planning the facilities and operation; however, aesthetic guidelines could not always prevail because of economic constraints and conflicting environmental requirements.

For additional information, see Section 6, Chapter 10, Aesthetics.

6.11 FISH AND WILDLIFE MANAGEMENT

Mitigation and enhancement measures presented in the Fish and Wildlife Management Plan are designed to "avoid, minimize, and/or mitigate damage to fish and wildlife habitat" in compliance with Section 4, Environmental Stipulation of the Tract C-a Oil Shale Lease Agreement. Determination of potential adverse effects from the Modified In Situ (MIS) development of Tract C-a was made through analyses of baseline environmental data, evaluation of mining plans, and completion of a "cause-effect" matrix analysis. Results of this impact assessment are presented in Section 7.

Aquatic habitat in the area is limited almost exclusively to ephemeral streams, and small streams and seeps. Baseline studies indicate that no fish occur on the tract; therefore, restoration of fisheries habitat is not required. Hydrology studies have indicated that mine dewatering may result in the lowering of water levels in springs and seeps connected to the upper aquifer. The assessment and mitigation of these impacts is presented in Section 7, Chapter 6. Related impacts to the terrestrial system are discussed in Section 7, Chapter 4.

The Fish and Wildlife Management Plan is designed chiefly to restore or mitigate lost terrestrial habitat. Projected mining plans will result in a temporary loss of approximately 471 acres of terrestrial habitat during the Modular Development Phase and an additional 1,288 acres during the Commercial Phase (Table 1-6-4). Current revegetation plans call for the revegetation of 427 acres of the modular disturbance and 1,027 acres of the commercial disturbance as soon as practical following cessation of disturbance. This will result in the net loss of 44 and 261 acres of habitat during the Modular Development and Commercial Phases, respectively. The lease stipulates that it will be necessary to modify adjacent habitat to compensate for this loss. Approximately 70% of the area to be disturbed is pinyon-juniper. The remainder is sagebrush and mixed brush. This will result in the loss of approximately 36 animal unit months (AUM's) of support vegetation which will be mitigated by the implementation of a successful wildlife management program. Some

Table 1-6-4

ACRES OF TERRESTRIAL HABITAT TO BE DISTURBED AND REVEGETATED, OR MODIFIED DURING RBOSP MINING ACTIVITIES PLANNED FOR TRACT C-a

	Acres	1978 - 1982	1983 - 1986	1987 - 1991	1992 - 1996	1997 - 2001	2002 - 2006	2007 - 2011	2012 - 2016
Mine and Plant Site	Disturbed	60	218						
	Modified [1]								[2]
Run of Mine Disposal Area	Disturbed	65							
	Revegetated		65						
Crushed Ore Disposal	Disturbed		260						
	Revegetated		200						60
Corridors	Disturbed	133	39	104					
	Revegetated	92	53	104					
	Modified								
Processed Shale Disposal Pile	Disturbed		70	320	210	40	40		
	Revegetated				20	215	215	215	275

[1] Represents habitat to be modified as part of the Fish and Wildlife Management Plan.

[2] The acreage and/or date are unknown at this time but habitat disturbance, revegetation or modification will occur during the period indicated.

modification will be conducted outside tract boundaries when advisable in a cooperative effort between the BLM, CDOW, and RBOSP.

The RBOSP Fish and Wildlife Management Plan is designed to mitigate all unavoidable adverse impacts to fish and wildlife habitat. Means for mitigating these impacts include habitat conversion, habitat modification, construction of structural habitat, habitat restoration and human disturbance control. Habitat conversion and modification techniques will provide additional forage and browse for domestic livestock and wildlife. Structural habitat and water availability improvements will increase the quality of existing habitat. Revegetation will insure the successful and timely reestablishment of wildlife in disturbed areas on Tract C-a. The management plan is designed to address the multiple interests of range management, wildlife resources, protection of feral horses and provision for balanced habitat. It will be coordinated with CDOW and BLM efforts under the supervision of the AOSS.

Four habitat modification means are suggested:

- Modification and/or conversion of existing habitat.
- Construction and/or retention of structural habitat.
- Increasing water availability.
- Restoration of habitat loss or creation of new habitat.

Modification of existing habitat can be accomplished by mechanical methods (crushing, chopping, rotocutting, chaining, railing, etc.), chemical methods (foliage spraying, stem spraying, application of soil sterilants), burning or enhancement by aerial seeding, fertilizing, interseeding and mechanical preparation of seed beds.

Recommendations for Tract C-a include conversion of pinyon-juniper and, possibly, sagebrush scrub. Pinyon-juniper modification will be accomplished by double chaining, windrowing, selected burning, fertilization and seeding. Sagebrush conversion will be accomplished by railing.

Construction of structural habitat (i.e., brushpiles, windrows) will be used by RBOSP to improve use of existing habitat. These structures provide additional shelter for small wildlife and allows them to utilize previously unavailable areas.

Disturbed land will require restoration after construction and disposal activities by revegetation of disturbed areas. During the 30-year period of the project, 1,475 acres of disturbed lands will require revegetation. The development ore and processed shale disposal piles will constitute 85% of this area. Revegetation will be accomplished by the procedures described in the control plan (Section 6, Chapter 8.4).

Increased human presence in area will result in assorted impacts to wildlife and habitat including:

- Increased hunting.
- Vehicle-animal collisions.
- Off-road use of vehicles.
- General harrassment of wildlife.

Plans to mitigate these impacts include a public relations effort to inform employees and the public of the impacts of human presence to wildlife. Additional efforts will include: posting of speed limits and deer crossing signs, restricting off-road vehicle use, restricting access to newly seeded areas and restricting the use of firearms.

The management plan will be monitored to determine the effectiveness of mitigation efforts. Habitat (forage and browse production, percent cover, and browse condition and utilization) will be measured at selected intervals before and after conversion/modification to determine the condition of the modified habitat. In addition, occurrence and use by wildlife (i.e., small mammals, avifauna, mule deer and feral horses) will be monitored to determine enhancement success.

For additional information, see Section 6, Chapter 11, Fish and Wildlife Management.

6.12 PROTECTION OF OBJECTS OF HISTORIC AND SCIENTIFIC INTEREST

During the baseline period, intensive cultural resource surveys were conducted to determine the presence and significance of cultural resources on and in the vicinity of Tract C-a. Archaelogic, paleontologic and historic studies were conducted. No significant historic or paleontologic finds were discovered. However, two archaeologic areas were judged to be of potential significance for nomination to the National Register of Historic Places, as defined in National Historic Preservation Act of 1966 and expanded in Executive Order 11593 of May 1971.

One area, identified as Site Cluster II, is a multi-component site consisting of a moderate number of open campsites and lithic tool scatters with a temporal span ranging from Archaic to Ute. The location, spatial and temporal extent of these campsites indicate repeated use of the area by various people over a relatively long period of time. This extended use of the area could possibly mean that subsurface materials lie buried in the area which could contribute significantly to the pre-history of the region. This potential provided the basis for nomination of the cluster to the National Register of Historic Places.

The second site, 5RB13, is a single component site at which a very old ($\sim$ 4,000 years) Paleo Indian projectile point fragment was discovered. The extreme age of this point provided the basis for nomination to the register.

Early in 1977, in compliance with Executive Order 11593, the BLM issued a "Determination of Effect" regarding the potential effects of proposed open-pit mining plans on Tract C-a cultural resources. In that "Determination of Effect", the BLM required the avoidance, or where avoidance is not practical, the flagging, testing and recovery of artifacts from Site Cluster II and the avoidance, testing and salvage of 5RB13. The "Determination of Effect" further provided for the immediate notification (to the AOSS) of any new cultural resource finds during development operations. Since the limit of disturbance during the currently

proposed mining plans (MIS Development) will disturb less acreage than the previously contemplated (Open-Pit Development), RBOSP requested the issuance of a revised "Determination of Effect" for the MIS mining plans.

Protection of objects of scientific and historic interest for the revised mining plans will be identical to those originally established by the BLM for open-pit mining methods. These protective measures are more than adequate to provide protection of these resources.

For additional information, see Section 6, Chapter 12, Protection of Objects of Historic and Scientific Interest.

6.13 SUBSIDENCE CONTROL

Although disruptive surface subsidence is not a certainty, there is evidence that it is a possibility. Retorts of both the Modular Development and Commercial Phases will be monitored by surveying methods to detect subsidence and quantify it. Monitoring will also include detection of retort off-gas escape to the surface by odor and instruments. Should knowledge gained in the Modular Development Phase indicate that disruptive surface subsidence will occur in the Commercial Phase operation, slurry backfilling of the spent retorts will be investigated as a means of preventing it. If disruptive surface subsidence cannot be prevented, the subsided areas will be appropriatly rehabilitated. Minor subsidence that does not seriously disrupt the surface may require no mitigative action.

For additional information, see Section 6, Chapter 13, Subsidence Control.

6.14 ABANDONMENT

Because of the wide variety of possible abandonment schemes, it is not possible to propose a definite plan of action at this time. RBOSP recognizes the requirement of submitting an abandonment plan which would be subject to AOSS approval prior to abandoning the lease. Initially, a showing of compliance with the terms of the lease by RBOSP would be submitted to the AOSS and, upon its acceptance, a notice of relinquishment would be filed as provided in Section 28 of the lease. Buildings and equipment on the lease would be sold to the government at appraised value or removed by RBOSP at government option, as prescribed in Section 32 of the lease.

The guidelines described in Section 6, Chapter 14, Abandonment will be used to prepare detailed abandonment plans and procedures prior to abandonment activities. Of course, if the facilities should be sold by RBOSP as an operating facility, the demolition, salvage and rehabilitation activities would not take place. Also, for a period of six months after termination of the lease, the lessor has the right to purchase, at the appraised value, any or all items on the lease required or useful for the protection of the leased lands.

Design of the abandonment activities will be governed by the various environmental protection plan concepts. The objective will be to return the site to a stable ecological state that will not contribute to continuing environmental deterioration and will be consistent with the appearance of the surrounding area. All required monitoring programs will continue until the AOSS has determined to his satisfaction that environmental conditions have been established after termination of the development operations which are consistent with the requirements of applicable Federal and State statutes and regulations. However, the AOSS may terminate this requirement at an earlier date when it is in the public interest.

The degree to which abandoned retorts are likely to affect the quality of groundwater will be assessed in the Modular Development Phase. This will be done by passing water through the burned-out retort and analyzing the quality of the effluent. Should it be found that degradation of groundwater by abandoned retorts is likely to be a problem, mitigating means will be adopted, such as the intentional leaching of soluble salts with subsequent cleanup of the leachate, isolation of the retort by grout curtains, or slurry backfilling of the retort. Other abandonment procedures will include sealing of mine openings from access (if appropriate) and correcting any remaining disruptive subsidence by contouring and revegetation.

Abandonment of the processing facility will involve several stages. These will include: salvaging and removing aboveground structures and piping; demolishing concrete structures down to grade; breaking up concrete and asphalt surfacing; plugging and abandoning underground piping, culverts and drains; and recontouring all graded areas through slope rounding, cutting, filling, and other earthwork discussed in 6.8 of this chapter. After the land has been restored to a natural appearance, it will be revegetated and rehabilitated to a usable and productive condition consistent with or equal to pre-existing land uses in the area and compatible with existing adjacent undisturbed areas.

Processed shale and development ore disposal site abandonment will require little more than completion of the rehabilitation and revegetation activities that will be continuing throughout the life of the project. Final abandonment activities will include removal of irrigation facilities, temporary fencing, obliterating access roads, reshaping abandoned ponds, ditches, and dikes, and dismantling, salvaging and removing any conveyors used in the disposal operations. Affected areas will be revegetated and rehabilitated to conditions not requiring further maintenance.

Abandonment of support facilities will follow the same stages as discussed for the processing facility. If desired, some features such as

clean-water impoundments, selected roadways, selected pipelines and power lines, etc., may be left in place for other uses. Determination of the facilities to remain, if any, will be made at the outset of detailed planning of the abandonment activities to ensure that no desired facility is inadvertently destroyed.

For additional information, see Section 6, Chapter 14, Abandonment.

CHAPTER 7
ENVIRONMENTAL ASSESSMENT

7.1 INTRODUCTION

Oil shale development on Tract C-a will affect air quality, terrestrial and aquatic ecology, surface and subsurface waters, and cultural resources. An environmental assessment of potential impacts was conducted to determine the extent and adversity of these impacts. Appropriate mitigation measures to offset these impacts were formulated.

Impact assessments were quantified by a "cause-effect" matrix analysis, in-depth analysis of baseline data, and a careful study of proposed mining plans. The matrix analysis consisted of a systematic ranking procedure during which the "importance" and "severity or magnitude" of all potential impacts were rated on a scale of one to five. To account for differences between the Modular Development and Commercial Phases the analysis was performed twice.

Ratings were made by experts in various fields who were thoroughly familiar with mining plans and environmental baseline data (in their area of speciality). The rating values were carefully defined. Following completion of the initial rating process, each participant was given the opportunity to review ratings in other disciplines and to reevaluate their own rating values.

This matrix analysis approach provided the following advantages:

- Consideration of all areas potentially affected.
- Effective detection of gaps or missing information.
- Qualification of sources of impacts early in the assessment process.
- Comparison of impacts between disciplines.

Matrix analyses indicated the Modular Development Phase impacts will generally be less severe than Commercial Phase impacts. This is largely a function of the extent and duration of planned activities.

Greatest impacts will probably affect surface and subsurface water resources. Impacts on vegetation and fauna will be limited to the immediate vicinity of the tract. Soils will be subject to increased erosion. Air quality will be impacted to a moderate degree in the area of particulate and gaseous concentrations, and visibility. Noise levels will rise. Impacts to aquatic biota will be limited, because aquatic populations within the tract vicinity are limited.

Overall, the impact of Tract C-a development by MIS mining methods and associated activities will be localized. Almost all impacts will occur within tract boundaries except for secondary impacts of human influx into the previously rural area and, possibly, dewatering effects.

7.2 ENVIRONMENTAL SETTING AND WILDLIFE INVENTORY

Physical and biological components of Tract C-a and vicinity have been thoroughly evaluated during 2 years of extensive baseline studies. Complete descriptions of these components can be found in the RBOSP quarterly progress reports and the Final Environmental Baseline Report. A summary of these conditions is provided in Chapter 2 of Section 7.

The tract is located in northwest Colorado about 20 miles southeast of Rangely. The tract occupies about 5,100 acres of pinyon-juniper and sagebrush rangeland. It is on the west flank of the Piceance Creek basin which is about 1,600 square miles in area. The edges of the basin lie near the rim of the Roan Plateau. Streams draining the exterior faces of the plateau are short, few in number, and have steep gradients. Piceance Creek and Yellow Creek and their tributaries drain most of the basin's interior and are longer and more gently sloping. The topography

of the basin is characterized by a series of parallel north and northeasterly trending ridges and valleys.

The area is relatively remote and supports limited evidence of man's intrusion. Roads leading into the tract, while improved (widened), are unpaved and often quite rough and dusty. Scattered ranches and abandoned homesteads occur along the roadways leading into the tract. Structures on the tract are limited to a relatively recent but now abandoned hunting club and a visitor information center and first-aid trailer erected by RBOSP after initiation of exploratory activities.

The oil shale underlying the tract was deposited during Eocene time in an ancient lake known as Lake Unita. Most oil shale in this deposit is actually a dolomitic marlstone which contains varying amounts of organic matter (kerogen) derived chiefly from algae, aquatic organisms, waxy spores, and pollen grains. The oil shale deposit is delineated into 19 alternating relatively rich and lean zones. Dawsonite is present in seven of these zones. Limited amounts of nahcolite occur in the deposit.

Beds within the tract strike generally to the north and dip (slope) to the east and northeast at a rate of 200 to 350 feet per mile ($2\text{-}4^{o}$). One major anticline and three major fault systems are present within the tract, along with four minor folds and multiple subsidiary faults. Surface displacements range from a few feet to more than 230 feet.

Overburden above the oil shale deposit varies considerably throughout the tract dependent upon abrupt local changes in topography and regional dip. Overburden is thinnest on the far western edge of the tract and thickest near the northern border.

Land use is currently confined largely to cattle grazing, big game hunting (mule deer), and oil and gas field development. Most of the tract is public (BLM) land with small parcels of State owned (CDOW) land interspersed among BLM holdings. The BLM allows cattle grazing in the

area by means of grazing allotments. Tract C-a falls within the confines of two current grazing allotments.

The tract lies within big game management unit 22 (CDOW), one of the most popular mule deer hunting areas in the state. Limited small game and waterfowl hunting is also practiced in the area. No fisheries habitat occurs in the immediate vicinity of Tract C-a but some trapping is practiced.

Feral horses occur in moderate numbers on the tract and surrounding areas. The remains of several horse traps in the area reveal that local ranchers once captured these animal for sport or profit.

In prehistoric times, Ute Indians and older cultures utilized the pinyon nut and deer herd as food sources.

Tract C-a lies in the Piceance Creek hydrologic basin, and is drained by Yellow Creek and the White River. It lies outside the immediate drainage basin of Piceance Creek. Surface water sources are limited to small intermittent streams and aquifer-fed springs and seeps. Peak stream flows occur during spring snow melt periods. Low flows occur in late summer or early fall. Precipitation ranges from 10 to 17 inches per year.

The groundwater sources in the area occur in one of three distinct systems--alluvial aquifer, upper artesian aquifer, and lower artesian aquifer. Water flows in the alluvium vary with seasonal stream flows. Water quality of the upper artesian aquifer is generally good; the lower aquifer is less desirable, containing appreciable amounts of calcium, magnesium, and sulfate.

Air quality is generally good. Most air constituents are at the lower limits of instrument detection. Only ozone, hydrocarbons, and particulates occur at other than expected concentrations. High particulate concentrations are probably related to the arid climate, unpaved roads, and high average wind speeds.

Weather patterns are related to the surrounding mountain terrain as well as local topography. Winds are predominately from the west, interrupted occasionally by migrating frontal systems. Most days are clear and sunny, with moderate temperatures during all seasons. Over half the seasonal precipitation falls as snow during late winter and spring. Baseline precipitation amounts appear to be below regional norms.

Most of Tract C-a is covered by pinyon-juniper and sagebrush vegetation types which overlap at various elevational ranges. Cover and productivity vary between north- and south-facing slopes. To the west of Tract C-a on Cathedral Bluffs, mixed stands of aspen, Douglas fir and mixed brush occur. Limited riparian (water-oriented) habitat occurs along drainages on and near the tract.

Thirty species of small mammals are known to occur in the habitats of the study area. Small rodents (deer mice and chipmunks) are most numerous. Rabbit and hare populations are relatively low, but seem to be increasing. Predators such as coyotes, bobcats, and weasels occur in low to moderate numbers.

Mule deer are found in the area throughout the year, but tend to use the area most as transitional or mild winter range. Elk are found in low numbers at higher elevations west of the tract. Cattle use the range extensively during summer and early fall, and feral horses are present in the area year-round.

One hundred thirty-nine bird species have been identified in the study area, including two species of upland game birds, two migrant shorebirds, and 14 raptorial (predator) species. Two endangered species, the peregrine falcon and the whooping crane, occasionally use the area.

Three amphibian (frogs, toads) and five reptilian (snakes, lizards) species occur in the vicinity.

Habitat suitable for the propagation of fishes does not occur on tract. Ephemeral streams and small springs and seeps support diverse communities of plankton (free-floating microscopic plants and animals), periphyton (attached, microscopic plants and animals), macroinvertebrates (small bottom-dwelling animals) and aquatic plants.

Cultural resources in the area include numerous open campsites or lithic (stone) tool scatters, remains of Ute Indian wicki-ups, recent horse traps, abandoned homesteads and ranches, and a few fossilized bones of the Eocene epoch. Two archaeologic sites in the area have been nominated to the National Register of Historic Places. The importance of cultural resources in the area lies largely in the fact that little is known about its prehistory. No totally unique finds were recovered from the area.

7.3 ASSESSMENT AND MITIGATION OF POTENTIAL IMPACTS TO AIR QUALITY

The Modular Development Phase of Tract C-a development will result in some elevated particulate levels on site and the possibility of some fugitive dust emissions off site. The gaseous emissions from the thermal ozidizer and a medium sized power boiler will be discharged through stacks located on Airplane Ridge between Corral Gulch and Box Elder Gulch, one of the higher elevations on the tract. With this elevation of the release point, ground level ambient air concentrations of pollutants will be well within State and Federal standards and should meet the non-degradation requirements for a Class II region.

The Commercial Phase of tract development will result in emissions from an on-site gas-fired turbine power generation facility, several thousand automobile trips to and from the site daily, emissions from an above-ground retorting facility, some emissions from transport and crushing shale rock, and the potential of windborne particulates from processed shale disposal storage. Of these, the largest source will be the power generating facility. These emissions will be vented through stacks located on Airplane Ridge at one of the higher elevations on the tract.

Because of the existing very low level of most pollutants in the tract area, there will be a measurable change in site air quality as a result of development. Sulfur oxides and NO_x will be produced by combustion of fossil fuels and MIS product gas in gas-fired turbine operation, carbon monoxide and hydrocarbons will result from automobile traffic, and minor amounts of particulates will result from traffic, crushing operations, and transport and disposal of processed shale.

During certain meteorological conditions, the concentration of pollutants off site will be greater than on site. In no case will the pollutant levels as a result of release from the tract exceed Federal primary or secondary standards. Colorado Category II increment levels for SO_2 may be exceeded, however. These standards have been established on the basis of no adverse effects on people, wildlife, or vegetation.

Proposed development is not expected to appreciably affect meteorological conditions--regionally or locally.

7.4 ASSESSMENT AND MITIGATION OF POTENTIAL TERRESTRIAL IMPACTS

Various activities associated with Tract C-a development will result in direct and indirect impacts to terrestrial habitat and wildlife. Direct impacts include:

- Physical destruction or damage of habitat and wildlife from construction.
- Loss of habitat available for wildlife use by fencing or other obstruction.
- Damage to habitat by airborne effluents (gases, dust).
- Wildlife stresses caused by noise or human presence.
- Loss of water from mine dewatering.
- Potential contamination of ground and surface waters.

Indirect impacts, related to increased human presence, include:

- Increased recreational use.
- Increased road kills of wildlife.
- Increased human harassment of wildlife.

Activities which will produce these potential impacts include: construction (surface facilities, roads, buildings, and other ancillary facilities); mining activities (movement of men and machinery, blasting, dewatering, ventilating, etc.); operations (processing, gas compression, power generation); storage, transfer and disposal of chemicals, shale ore, processed shale, machinery, etc.; human presence; potential subsidence and environmental actions (sampling, mitigation efforts).

Duration of these activities will vary during the life of the project. Initial development (Modular Development Phase) will be less extensive than operational development (Commercial Phase). Combined habitat disturbance during the Modular Development Phase will total approximately 471 acres. Disturbance during the Commercial Phase will approach 1,288 acres.

Modular Development Phase activities can potentially affect areal extent of available habitat, result in the loss or displacement of limited numbers of small mammals and birds, reduce availability of surface water supplies, affect local migration patterns of mule deer, and result in increased road kills of wildlife. The limited extent of Modular Development Phase activities in concert with planned mitigation procedures will reduce these impacts. Habitat restoration and enhancement procedures will effectively compensate for terrestrial impacts and reduce the net impact of Modular Development Phase activities to near zero.

Commercial Phase activities will result in a larger degree of disturbance and more profound impacts on the terrestrial system. Areal extent of habitat loss will result in greater loss and/or displacement of wildlife than Modular Development Phase activities. Fugitive dust and gaseous

emissions will increase, noise levels will be moderately high, water supplies may be affected to a greater degree, and potential subsidence may occur. Mitigation measures are designed to reduce impacts by restoring or replacing lost habitat with improved habitat by augmenting lost water supplies, controlling dust and gaseous emissions, and control of noise and subsidence. Not all impacts of the Commercial Phase can be totally mitigated. This is particularly true of disturbances related to increased human presence. Unfortunately, it is impossible to predict and plan for these types of impacts. Planned mitigation measures should effectively reduce direct Commercial Phase impacts to local significance.

7.5 ASSESSMENT AND MITIGATION OF POTENTIAL AQUATIC IMPACTS

Aquatic habitat on Tract C-a is limited to ephemeral (intermittent) streams and small springs and seeps. No fishery habitat occurs within tract boundaries. Proposed oil shale development will have limited impact on these aquatic resources.

Major sources of impact for both phases (Modular Development and Commercial) include construction disturbance, increased use of roads, and installation of pipeline networks which will result in damage to aquatic habitat by in-creased siltation. This temporary increase in siltation will reduce periphyton production and result in changes in community composition for periphyton and benthos communities. Flows in certain spring brooks will be reduced by mine dewatering. This impact will also primarily affect periphyton and benthos communities. The zero surface water discharge concept and water control plans employed by RBOSP will effectively mitigate the majority of surface water impacts.

7.6 ASSESSMENT AND MITIGATION OF POTENTIAL HYDROLOGIC IMPACTS

The engineering and design of the Tract C-a development plan is based on zero discharge of surface water used for these processes. This principle

minimizes potential impacts to surface and groundwater resources. Remaining environmental impacts on the hydrology are confined to dewatering, mining, and abandonment of burned-out retorts.

Matrix analysis of potential development impact indicates that construction of underground retorts, dewatering, reinjection, disposal of MIS retort water and mine seepage water, and subsidence will potentially impact the hydrology of the area. Other actions will have potentially little affect on the hydrologic environment.

Mining of oil shale on Tract C-a must be preceded by mine dewatering. The rate and time of dewatering were projected through use of a computer model. Results of this model are tentative and will be confirmed with additional computer runs once mining plans are finalized.

Dewatering of the upper aquifer will be required during the Modular Development Phase. The lower aquifer will require partial dewatering during the early years of the Modular Development Phase (Retorts 1 through 5). Dewatering of the lower aquifer will be required during construction of Retorts 6 and up during the Modular Development Phase.

Effects of mine dewatering will be mitigated by reinjection. Mine water will be reinjected at a distance of 3-1/2 to 5 miles from the tract boundaries, the exact locations of which have not yet been determined.

Groundwater discharge to Yellow Creek may be impacted. Augmentation plans have been prepared to mitigate this impact, if it occurs. Methods to be considered are:

- Water replacement by means of a water delivery system from RBOSP.
- Dedication of water of existing water rights to the stream.
- Release of groundwater to the streams.

Impacts to the hydrology during the Commercial Phase will be the same as during the Modular Development Phase except they will be extended over a longer time. Similar mitigation measures will be used.

7.7 ASSESSMENT AND MITIGATION OF IMPACTS ON CULTURAL RESOURCES

Development activities such as clearing, grading and road and pipeline construction have the potential to adversely impact cultural resources within the area of disturbance. Adverse impacts result from loss of surface and subsurface artifacts through physical destruction or burial, physical removal of structures or remains, or disruption of natural features which represent a cultural period or activity. Total surface disturbance on Tract C-a may equal 1,800 acres.

Only two archaeologic areas in the vicinity are considered worthy of protection under a "Determination of Significance" as prepared by the Bureau of Land Management, January 1977. These two areas, Site Cluster II near 84 Ranch and 5RB13 in the southeast corner of Tract C-a both lie in areas which might eventually be disturbed by tract development activities.

To protect these sites, RBOSP will first attempt to avoid their disturbance. If disturbance is necessary, RBOSP will provide for the testing and salvage, if necessary, before development proceeds.

Previously undiscovered cultural resources will be reported immediately, and work in the discovery area will stop until authorization to proceed is received.

For detailed assessments and descriptions of appropriate mitigation procedures, see Section 7, Environmental Assessment.

CHAPTER 8
ENVIRONMENTAL MONITORING

8.1 INTRODUCTION

Development of oil shale on Tract C-a will extend over a number of years during which land will be cleared for roads, mining and processing facilities, disposal areas, and support facilities. TOSCO II processing and gas turbine operation will produce gaseous and particulate emissions. Dewatering will be necessary to prevent flooding of mine passages from subsurface aquifers and may lead to disruption of groundwater flows to surface springs and seeps.

These and other development actions will unavoidably result in impacts or changes in the natural environment. RBOSP will implement a variety of mitigation measures to prevent or lessen anticipated impacts. To test the success of planned mitigation measures, RBOSP will monitor the type, severity, and duration of impacts which result from oil shale development. Changes caused by development activities will be gauged against baseline "norms" established during the two years of baseline studies.

Identification of potential development perturbations was accomplished by use of a "cause-effect"matrix. Proposed actions were plotted against potentially affected environmental parameters and rated on a scale of 1 to 5. All ranking couplets of 3/3 or higher were considered important enough to receive further consideration for monitoring purposes. To further quantify the parameters for monitoring, a measurability matrix analysis was conducted to establish the feasibility of collecting statistically significant data for the parameters in question. All couplets of 3/3 or higher were ranked for measurability on a rank of 1 to 5. Measurability was based on experience with baseline data analysis and results, expert judgement of specialists in the field, and consultation with a biostatistician.

The resulting monitoring program was designed to gather statistically reliable data on a limited number of factors. These factors should reflect environmental conditions on Tract C-a.

Ambient air quality and meteorology will be monitored at three sites, including the point of maximum concentration.

Terrestrial parameters to be monitored will include plants, animals, and soils in the study area. Effects of salt drift, particulate emissions, mine dewatering, processed shale disposal, revegetation and habitat modification will be monitored.

Aquatic monitoring methods are designed to test the effects of oil shale development on important aquatic communities which occur in the area.

Hydrology monitoring will be carried out to assess effects of mine dewatering and reinjection on groundwater and surface water quality and quantity. The monitoring program will also test the effects of subsurface retort burning on groundwater quality.

Revegetation programs for disturbed areas will be monitored, where appropriate, to determine success and to formulate new methodologies.

Subsidence and noise will also be monitored to assess potential human health, safety, and wildlife hazards.

8.2 AIR QUALITY

The existing air quality on and around Tract C-a may be characterized as generally very good. The ambient air concentrations of sulfur dioxide, nitrogen oxides, hydrogen sulfide and carbon monoxide are all very low. The natural background of suspended particulate matter is also very low in areas that are reasonably inaccessible to the public. Near unpaved

roadways particulate concentrations rise on weekends and holiday periods to the point where State and Federal standards for 24-hour average concentrations are occasionally exceeded.

The natural concentration of total oxidants, measured as ozone, also occasionally exceeds the Federal standard. There is currently no activity on or around the site to contribute to the measured concentrations of ozone. The cause of the high ozone levels is not well known, and is under investigation by EPA and others. Ozone levels in excess of the Federal standard have frequently been found throughout the country, including sparsely populated areas.

Levels of non-methane hydrocarbons that exceed State and Federal standards have been measured on the tract. There is no activity on-site or in the vicinity of the site which could contribute to these levels. Ambient air hydrocarbon concentrations appear to undergo diurnal variations. The heating and cooling of vegetation may contribute to the high hydrocarbon concentrations observed. It is also possible that solar heating of the ground surface may promote the emission of the more volatile fractions of hydrocarbons in the soil and in oil shale on the surface.

The Modular Development Phase will require energy. This energy will be developed by a fossil-fueled steam boiler and the thermal oxidation of MIS gases. These activities will result in the emission of sulfur dioxide, a small amount of nitrogen oxides, and some fugitive hydrocarbons.

Air quality monitoring will be conducted at three specific locations to measure levels of development-related pollutants. Site 1, just west of the tract boundary, will measure pollutants in the region of maximum impact. Site 2 will record the quality of the air entering the area of the operations. Site 3 will provide data on the dispersion of pollutants in the natural drainage air flow from the site.

Air quality background will be monitored for suspended particulates, sulfur dioxide, nitrogen oxides, methane and non-methane hydrocarbons, carbon monoxide, and ozone. The downwind monitoring site will monitor suspended particulates, sulfur dioxide, hydrogen sulfide, carbon monoxide, nitrogen oxides, ozone, and methane and non-methane hydrocarbons. Off-site monitoring will include suspended particulates, sulfur dioxide, nitrogen oxides, ozone, and methane and non-methane hydrocarbons.

The Commercial Phase will include the addition of an on-site power generating facility consisting of multiple gas turbine units that will use treated MIS gas as fuel. The gas turbines emit nitrogen oxides. This phase will also include some surface retorting of shale which will result in the emission of sulfur oxides and hydrocarbons. The proposed height of release of waste gases for the Commercial Phase is similar to that proposed for the Modular Development Phase and, except for differences in plume rise due to gas temperatures, the diffusion of waste gases in the atmosphere is expected to be similar for both phases.

A monitoring program to evaluate visibility ranges in the tract area will also be conducted. While no regulations cover visibility, this parameter is a sensitive measure of regional air quality. Slight changes in the concentrations of suspended particulates, nitrogen oxides, sulfur dioxide and non-methane hydrocarbons have the potential for creating hazes, especially in the strong sunlight that is common to the region.

8.3 METEOROLOGY

The dispersion of pollutants generated during development will be largely controlled by atmospheric characteristics. Wind patterns at ground level are strongly influenced by the topography of the tract area (e.g., air moves up or down the gulches, depending on the time of day). Surface generated pollutants can be entrained in these flows. Elevated releases,

such as from stacks on ridges, will be injected into wind flow patterns 100 m or more above the ridges and may undergo considerably different distributions than would emissions released at the surface.

A study of the baseline data has shown that surface wind flows in the gulches may be adequately monitored by the existing 10 m wind direction sensor on the tower at Site 1. The wind direction sensors located at the 60 m level on the existing tower are adequate to monitor wind flow patterns above the ridges on the tract. There appears to be no reason to change the location of the meteorological monitoring facility for the long-term extensive environmental monitoring effort. The meteorological data to be acquired at Site 1 include: wind direction and speed at elevations of 10 m and 60 m; the ambient air temperature and dew point at the 10 m level; solar radiation at 2 m; the 10 m to 60 m differential temperature for atmospheric stability estimation; and wind sigma at 10 and 60 m.

Additional data will be collected at baseline monitoring Sites 2 and 3.

8.4 TERRESTRIAL ECOLOGY

Proposed development of Tract C-a will result in disturbances to terrestrial habitat which could adversely affect the distribution and abundance of wildlife in the area. Baseline data collected over the two-year period have been used to define the importance of various wildlife groups (small mammals, predatory mammals, large mammals, avifauna, invertebrates) in the Tract C-a terrestrial ecosystem. Habitat analyses have also been conducted on vegetative and soils components of the tract area to help quantify existing conditions and use.

Results of these analyses were used to help select terrestrial parameters whose monitoring would most likely provide indices of development-related perturbations.

Both abiotic and biotic factors have been included in the terrestrial monitoring program. Abiotic components to be monitored include soil conductivity and trace element concentrations at impact and control (non-impact) areas. These monitoring factors will provide information on the dispersion of salt and trace metals from stack emissions. Comparision of the values for these parameters against baseline norms will indicate if unexpected dispersion and/or deposition occurs.

Biotic monitoring will involve vegetation sampling, small mammal and avifauna studies, and large mammal (mule deer and feral horse) surveys. The vegetation monitoring program is designed to detect changes in vegetation distribution, composition, condition, and use by wildlife. Statistically valid data will be collected, where applicable. Adequate sample size for specific study locations will be determined. Control and impact sites will be studied.

Fauna will be monitored to assess impacts of oil shale development on important species in the area. Mule deer and feral horses will be monitored because of their importance to the public and, for horses, legal status. Small mammals and avifauna will only be monitored on habitat enhancement or revegetation areas to assess their use of these areas. Other animal groups will be excluded from the monitoring program because their study would probably not provide information adequate for assessing the impacts of development.

Mule deer density estimates will be calculated from pellet plot count data. Adequate sampling sizes will be determined during the first year of monitoring. The distribution and relative abundance of feral horses will be described qualitatively.

Small mammals will be monitored by trappings. Breeding bird studies will be conducted to determine species composition and relative abundance.

Monitoring data will be analyzed periodically and compared with baseline data to identify differences between conditions prior to development with those after development.

8.5 AQUATIC ECOLOGY

An analysis of two years of aquatic baseline data and of the potential impacts of Tract C-a development indicates that certain aquatic communities (periphyton and benthos) and certain physical parameters (water temperature, dissolved oxygen, pH, specific conductance, flow, velocity, depth, width, turbidity, substrate, type, alkalinity, suspended solids, and total dissolved solids) will provide monitoring data sufficient to assess natural and impact-related trends on aquatic ecosystems during development.

Periphyton and benthos occupy a dominant role in the aquatic ecosystems of Tract C-a. Their limited mobility makes them susceptible to physical and chemical changes. For these reasons, these organisms are good indicators.

The physical parameters selected for monitoring are those most likely to change because of development (e.g., increased siltation and turbidity, decreased flows), and which are of particular significance to aquatic organisms.

Data collected during monitoring will be compared with baseline data to determine if significant changes have occurred. Appropriate statistical tests, including analysis of variance, multiple range test and chi-square test will be used to make these comparisons.

8.6 HYDROLOGY

Hydrological monitoring techniques are designed to detect changes in surface and groundwater flows and quality which could occur as a result

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